

How Do Data Dashboards Affect Evaluation Use in A Knowledge Network?
A Study of Stakeholder Perspectives in The Centre for Research on Educational and Community
Services (CRECS)

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Legend

CRECS	The Centre for Research on Educational and Community Services
ECB	Evaluation Capacity Building
M&E	Monitoring and Evaluation
EA	Evaluability Assessment

Abstract

Since there is limited research on the use of data dashboards in the evaluation field, this study explores the integration of a data dashboard in a knowledge network, the Centre for Research on Educational and Community Services (CRECS) as part of its program evaluation activities. The study used three phases of data collection and analysis. It investigates the process of designing a dashboard for a knowledge network and the different uses of a data dashboard in a program evaluation context through interviews and focus group discussions. Four members of the CRECS team participated in one focus group; two other members participated in individual interviews. Data were analyzed for thematic patterns. Results indicate that the process of designing a data dashboard consists of five steps that indicate the iterative process of design and the need for sufficient consultations with stakeholders. Moreover, the data dashboard has the potential to be used internally, within CRECS, and externally with other stakeholders. The data dashboard is also believed to be beneficial in program evaluation context as a monitoring tool, for evaluability assessment, and for evaluation capacity building. In addition, it can be used externally for accountability, reporting, and communication. The study sheds light on the potentials of data dashboards in organizations, yet prolonged and broader studies should take place to confirm these uses and their sustainability.

Keywords: Data dashboard, data visualization, program evaluation, monitoring and evaluation, evaluation capacity building, evaluation use.

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Introduction

Despite the considerable investment of time and money to produce evaluation reports by organizations, evidence suggests that stakeholders rarely use evaluation findings to inform decisions (e.g., Mayne, 2009; Pollitt, 2006; Stame, 2004). Given the importance of evaluation use to evaluators, many authors and scholars have looked to technology as a way to increase stakeholders' involvement and ultimately improve evaluation use (Svensson & Cousins, 2015; Preskill, 2008; Snow & Snow, 2016; Walker & Mao, 2016), with a growing interest particularly in data visualization to communicate the findings (Evergreen, 2014; Azzam, Evergreen, Germuth, & Kistler, 2013). However, the research on data visualization in evaluation is limited. The few studies published on this matter only presume use as a natural outcome of good design (Evergreen, Lyons & Rollison, 2016). Therefore, the goal of this research project is to provide further insights to the evaluation field on the potential effects of data visualization, particularly data dashboards, on utilization of evaluation findings. In this research, I explore whether data dashboards, designed to align with stakeholders' needs, might support the use of evaluation findings, or focus their efforts on goal setting in ways that lead to a deeper focus on key evaluation indices. At the same time, the project seeks to clarify the possible limitations and challenges of incorporating these digital tools. Therefore, I will focus on examining three main areas: a) stakeholders' understanding of the evaluation findings, b) the effect of the data dashboard on evaluation use types, and c) stakeholder's perceptions of the data dashboard uses and limitations.

Literature Review

What is Evaluation?

Evaluation, by definition, is the application of systematic methods to address questions about program operations and results (Newcomer, Hatry & Wholey, 2015). According to the Organization for Economic Co-Operation and Development (OECD) definition, evaluation is “The systematic and objective assessment of an on-going or completed project or programme, its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives, development efficiency, effectiveness, impact and sustainability” (OECD, Guidelines for Project and Programme Evaluations 2009, p.1) Evaluation is an inquiry involving the gathering and assessment of information in a planned and methodical way (Alkin, 2010). Most simply stated, evaluation is judging the” merit” or “worth” of an entity (Alkin, 2010). Evaluations are carried out by professional evaluators either for formative or summative purposes, which require rigorous processes of collecting and analyzing data.

The Problem

Christie (2007) notes, “Evaluation utilization is arguably the most researched area of evaluation and it also receives substantial attention in the theoretical literature” (p.8), since it is believed that evaluation findings are usually left unused. In 2006, a survey of 1140 members of the American Evaluation Association reveals that 68% of respondents classified non-use of evaluation findings as a “major problem” (Fliescher & Christie, 2009). Evaluation use, then, is a major research pre-occupation and scholars have tried to identify the factors that affect it. Research suggests three categories of factors influence evaluation use: (a) characteristics of evaluation implementation (Cousins & Leithwood, 1986), (b) characteristics of the decision or policy setting (Cousins & Leithwood, 1986; Mayne, 2009; Alkin & King, 2016), and (c)

stakeholders' involvement (Johnson et al., 2009). The factors that affect utilization of findings are not the only concern; researchers also seek to identify how evaluation findings are used in organizations and the degree to which each factor contributes to evaluation use. Before elaborating on evaluation use and its types, I explore the ways that data dashboards may increase evaluation use.

Suggested Solution: Data Dashboards

By definition, data dashboards are visual representations that display the most important information needed to measure progress toward goals captured on a single screen (Few, 2006). Data dashboards have been identified in the evaluation research as tools for monitoring, analysis, and for presenting the data more effectively (Smith, 2013; Fetterman, et al., 2017). Scholars have highlighted the potential benefits of using technology in the evaluation field for its possible positive impacts on evaluation use. Among the technologies that may offer significant benefits is the data dashboard. The unique feature of data dashboards is the possibility of showing dense amounts of data clearly and concisely (Smith, 2013). In organizations, data dashboards are generally used for strategic purposes, analytical purposes, and operational purposes (Smith, 2013). For example, analytical data dashboards can be used to analyze students' performance in educational settings where data overload can exhaust assessors. In Competency-Based Medical Education (CBME), the new initiative to medical education, analytical data dashboards play a crucial role in monitoring residents' progress towards their competency goals by summarizing and analyzing huge amounts of data to monitor students' performance in real time and track progress over time (e.g. Thoma et. al., 2020). In the same context, data dashboards can contribute to program evaluation efforts since it can alert program directors to areas where action is needed like curriculum and faculty development. In order to

illustrate the possible benefits of using data dashboards to enhance evaluation use, it is important to provide a brief account in the coming section on types of evaluation use and possible uses of data dashboards for other activities in the evaluation process. First, however, I will provide a little background on the context of this study.

Research Context

The study was conducted at the Centre for Research on Educational and Community Services (CRECS). It is a bi-faculty research center at University of Ottawa that is focused on research, evaluation, and training. CRECS main goal is knowledge mobilization and social betterment. Therefore, it is considered as a knowledge network that collaborates nationally and internationally with community partners to produce new knowledge and mobilize existing knowledge in order to enhance policies, programs, and practices in education, social services, and health. I provide more explanation of CRECS mission and objectives and knowledge networks later in the paper under the title “Knowledge Network”. The coming section is on types of evaluation use and possible uses of data dashboards for other activities in the evaluation process.

Evaluation Use

Generally, evaluation use can be divided into two categories: (a) findings use and (b) process use. Findings use is learning from the findings of an evaluation study and using them in various degrees. On the other end of the spectrum is process use which is learning from the evaluation process and activities rather than the evaluation findings (Patton, 1997). Findings use has been categorized by the ways that the findings are actually used by organizations. These uses can be instrumental, conceptual, or symbolic.

Findings Use

Instrumental use. Instrumental use refers to the significant changes in programs upon the intervention of the evaluation, which leads to change in decision-making or problem-solving process (Svensson & Cousins, 2015; Alkin & King, 2016; Mayne, 2014).

Conceptual use. Conceptual use is more about a change in “understandings and attitudes of the program community members, but an absence of demonstrable change at the program level “(Svensson & Cousins, 2015, p.146). Conceptual use is more about learning and increasing knowledge that can be shown either in clarifying the program’s model, learning how to measure outcomes, reducing uncertainty about the program, enhancing communication, or providing illumination to the stakeholders (Patton, 1997).

Symbolic use. Symbolic use is what happens when evaluation is supported but there is no intention to use the findings at the time being (Patton, 2008). This type of use can be used as evidence for accountability (Patton, 1997).

Process Use

Patton (1997) introduces the term "process use" to the evaluation field as a new type of evaluation use. Patton (1998) explains that process use stresses the importance of stakeholders’ involvement and learning during the various stages of evaluation. Being engaged in the evaluation can be useful regardless of the findings as stakeholders learn to reason like an evaluator (Patton, 1997). Patton (1998) explains how the idea took his attention:

I have asked intended users about actual use. What I would typically hear was something like:

Yes, the findings were helpful in this way and that, and here’s what we did with them.” If there had been recommendations, I would ask what

subsequent actions, if any, followed. But, beyond the focus of findings and recommendations, what they almost inevitably added was something to the effect that “it wasn’t really the findings that were so important in the end, it was going through the process (p. 225).

Patton (1997) defined process use as “individual changes in thinking and behavior . . . that occur among those involved in the evaluation as a result of the learning that occurs during the evaluation process” (p. 90). Moreover, Patton (1997) explains that process use results in four primary uses of evaluation logic and processes: “enhancing shared understanding, supporting and reinforcing the program through intervention-oriented evaluation, increasing participants’ engagement, sense of ownership, and self-determination, program or organizational development” (p.91). In this sense and with the mentioned above types of evaluation, an important question that this research tries to explore is how data dashboards affect evaluation use either the use of the findings in any level of use or use that is manifested in learning from the evaluation process. Although evaluation use has been categorized into these two main types, it was further developed by other authors as will be discussed in the coming section.

Evaluation Capacity Building and Technology

Some authors have taken process use even further to an organizational level in what is known as Evaluation Capacity Building (ECB). The term refers to organizational efforts to cultivate evaluative thinking and learning into its structure through daily activities that enhance effective implementation and use of evaluation projects. It is important to note that ECB is the expansion of process use to include organizational learning and increasing organizational capacity for the creation of evaluation. Therefore, ECB is defined as “the intentional work to continuously create and sustain overall organizational processes that make quality evaluation and

its uses routine” (Stockdill, Baizerman, & Compton, 2002, p. 14). Preskill (2008) says, “We must consciously guide stakeholders and others along a more direct path that leads to their learning from and about evaluation theory and practice” (p.130). Cousins and his colleagues (2004) explain that ECB has two types: direct and indirect. According to them, ECB results in two important consequences: evaluation use and organizational learning. In this way, ECB cultivates a culture of self-assessment and self-reflection (Cousins et al., 2004). King & Volkov (2005) elaborate on the same idea explaining that ECB aims at supporting effective evaluation practices and ensuring their sustainability through some activities like increasing the capacity of organizations to design, implement, and manage evaluation projects effectively. In this context, technology can be a helpful medium in evaluation capacity building (ECB).

Preskill (2008) explains the potential of technology as a construct to enhance ECB that **“if we design and use technology appropriately within the evaluation profession, it has the potential for contributing to what and how people learn from and about evaluation”** (132). One of these uses is to “disseminate and improve access to information” (Preskill, 2008, 132). Building on Preskill’s suggestion, data dashboards can be a form of technology that improves access to data and may enable more effective ways of data and knowledge dissemination within ECB processes. Therefore, ECB can benefit from the use of data dashboards in the context of program evaluation.

As outlined below, the data dashboard in this research is designed to support findings use (instrumental, conceptual, and symbolic), process use, and Evaluation Capacity Building. However, given the paucity of research on the ways that data dashboards are used by knowledge networks to inform decision making, the study does not privilege a particular type of evaluation

use, or assume that the data dashboard will be useful in particular ways . In the following sections, I propose two more evaluation dimensions that may also benefit from data dashboards.

Monitoring and Evaluation (M&E)

Another framework where data dashboards can be of potential use is results-based monitoring and evaluation systems (M&E). Monitoring of performance is an ancient practice that goes back to the ancient Egyptians whose drawings on the walls of their temples show a monitoring system of the production outputs of their grains and livestock (Kemp, 2006). In the context of evaluation, monitoring and evaluation are distinct, yet complementary phases (Zall Kusek & Rist, 2004). The monitoring and evaluation cycle is illustrated in Figure 1. This figure represents the relationships between the three phases of evaluation – planning, monitoring programmatic progress in relation to the plan, and evaluation of outcomes, in relation to the plan. The United Nations Development Programme (UNDP) (1997) definition elaborates on the same idea that “monitoring and evaluation differ yet are closely related. They are mutually supportive and equally important. Monitoring can provide quantitative and qualitative data using selected indicators, data that can serve as inputs to evaluation exercises.” The OECD (2009) defines *Monitoring* as “a continuing function that uses the systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds” (p. 1). On the other hand, *Evaluation* is “the systematic and objective assessment of an ongoing or completed project, program, or policy, including its design, implementation, and results” (OECD, 2009, p.1). The aim is to determine the relevance and fulfillment of objectives, development efficiency, effectiveness, impact, and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation

of lessons learned into the decision-making process of both recipients and donors. In other words, Monitoring gives information on where a policy, program, or project is at any given time (and over time) relative to respective targets and outcomes. It is descriptive in intent. Evaluation gives evidence of why targets and outcomes are or are not being achieved. It seeks to address issues of causality. Therefore, Monitoring and Evaluation should be used in conjunction because, presenting performance data without providing the context and the reasons behind this performance is insufficient for drawing reliable conclusions on the effectiveness of programs (Zall Kusek & Rist, 2004). The need for monitoring data is important for the evaluation process, however these data need to be sufficient and accurate; insufficient or inaccurate information could obscure the development of a clear picture of the organization's activities and processes, which might affect the evaluation decisions as well. Data that are at the wrong level of aggregation, poorly presented or in the wrong form, have limited usefulness and could even be harmful.

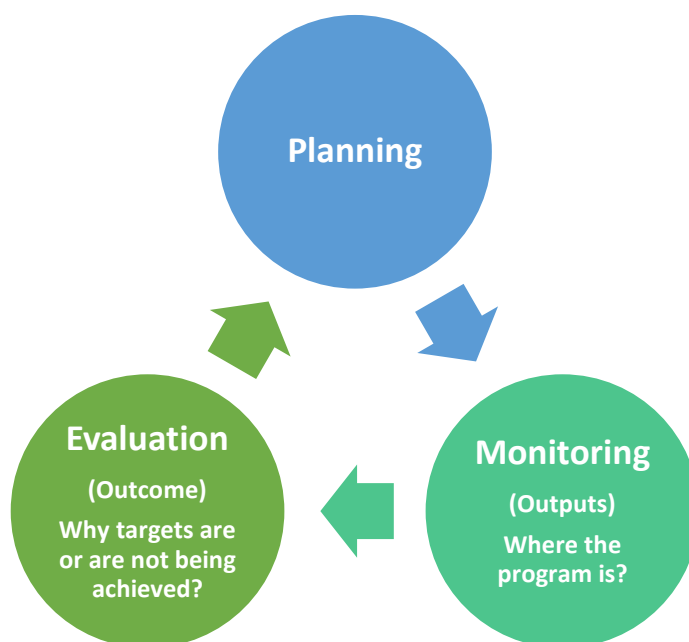


Figure 1. Monitoring and evaluation cycle.

Evaluability Assessment (EA)

Data dashboards have the potential to be useful for evaluability assessment (EA) purposes as well. EA is “The extent to which an activity or project can be evaluated in a reliable and credible fashion” (OECD-DAC 2010; p.21). The history of EA shows that it is used as a pre-evaluation activity to inform programs about their readiness for evaluation and help them get useful results (Davies, 2013). It has emerged as a response to the frustration among evaluation users when evaluations failed to produce valuable results to them (Trevisan & Walser, 2017). In EA, program structures were examined to determine whether that structure would yield useful results out of outcome evaluation (Wholey, 1979). A number of models to guide the implementation of EA have been developed (e.g., Wholey, 1979; Davies, 2013). Evaluability Assessment is now perceived as a distinct evaluation approach that can be used throughout an evaluation cycle (Trevisan & Walser, 2017). In light of this evolution, EA can be defined as the systematic investigation of a program’s context, characteristics, processes, activities, implementation, outcomes, and logic to determine how the theory of the program aligns with the way it is implemented, determine the validity of the program achieving its goals, and determine the feasibility and recommendations to further evaluations (Trevisan & Walser, 2017). Therefore, EA is considered as a decision-oriented approach that can serve a variety of evaluation purposes: formative, summative, or developmental purposes. EA results can be for formative purposes as it can provide recommendations on filling the gaps in the implementation process of a program. In other words, EA can be used throughout the lifecycle of a program for ongoing evaluation and monitoring as part of program management and/or as “ongoing participatory EA” (Thurston & Potvin, 2003, p. 454). Considering EA and its uses, data dashboards can be used to serve EA and help programs monitor their performance and progress

towards their goals. It is worth mentioning here that EA process can offer many benefits such as enhancing understanding, reinforcing evaluative thinking, fostering organizational learning and building the program's capacity for evaluations, which can be called process use (Trevisan & Walser, 2017).

Data Visualization

Human beings use data visualizations to make sense of the relationships among complex ideas. Data visualization has deep and old roots that go back to the Ancient Egyptians who used “the idea of coordinates in laying out towns” (Friendly, 2006, p.2). Data visualization, by definition, is illustrations of qualitative and quantitative data through images to facilitate communication and understanding of the data (Azzam et al., 2013). Andy Kirk (2012) defines data visualization as “The representation and presentation of data that exploits our visual perception abilities in order to amplify cognition”. In other words, “graphics are instruments for reasoning about quantitative information” (Tuft, 1983, p.11). Tukey (1977) summarizes the value of data visualization in this quote, “The greatest value of a picture is when it forces us to notice what we never expected to see.”(p. vi) This takes us to the story in the *New York Times Magazine* article titled “Selling Soap: How Do You Get Doctors to Wash Their Hands?”, in which Dubner and Levitt (2006) explain how the use of a photograph of a Petri dish of each doctor's hand and using it as a screen saver on each doctor's desktop has resulted in improved hand-hygiene compliance to nearly 100% after struggling for some time to meet the Joint Commission on Accreditation of Healthcare Organization's requirement of 90% compliance. One person commented on using the screen saver saying, “When you present them with good data, they change their behaviour very rapidly. Some forms of data, of course, are more compelling than others, and in this case, an image was worth 1,000 statistical tables” (Dubner &

Levitt, 2006, p. 24). This shows how the choice of the right and most effective visualization can transform people's thinking and behaviour.

Data visualization issues: Benefits and struggles

Across many sectors, organisational leaders use results to inform key decisions. Few (2012) uses the phrase "Show me the numbers" to refer to the demand to use numbers in workplaces to reveal the real performance that would replace uncertainty with reliable facts. However, Few (2012) adds that "numbers cannot always speak for themselves" (p.1). In this information age, poor documents and bad visualizations are still a challenge (Schriver, 1997; Few, 2012). Although there is a huge progress in terms of the software and programs for producing data visualizations there are still challenges to producing effective visualizations. Few (2012) adds, "Having the means to create graphs with a computer doesn't guarantee that we will do it effectively any more than having word processing software makes us great writers" (p.xvi). Therefore, it is crucial to know the techniques and rules of data visualizations in order to produce the most effective graphs, for "well-designed data graphics are usually the simplest and at the same time the most powerful" (Tufte,1983, p.11). Accordingly, data visualizations can hold some benefits for evaluation practice.

During evaluation processes, data visualization software, which can present complex data in simple multi-modal formats such as graphs or scales (Jewitt & Kress, 2010), may be useful during evaluation processes that require rigorous methods of data collection and analysis, because access to visual representations allow decision makers to understand evaluation findings. Data visualizations play a critical role when it is time to communicate evaluation findings as well. As Azzam, Evergreen, Germuth, & Kistler (2013) note, "Data visualization engages and supports program stakeholders by increasing their capacity to understand data and participate in

the evaluation process" (p.21). Evaluators can visualize data using data dashboards (Smith, 2013), infographics, or interactive conceptual models (Azzam et al., 2013). In Figure 2, I provide an example of a data dashboard that summarizes sales activities and outcomes. The red dots indicate business activities that fall short of expectations. Visually, this is easy to see and, as Few (2013) indicates, these simple visual cues can orient focus, and help decision-makers to orient their energies and resources toward the resolution of problems using data.



Figure 2. An example of an operational data dashboard (Few, 2013).

Data visualization can be beneficial to evaluation practice; however, it still faces the same challenges of poor design. Although graphs and charts are commonly used in evaluation reports, Evergreen (2011) conducted a study in which she found that many of the visualizations used in

evaluation reports tended to be confusing, potentially leading to misunderstandings and decision errors on the part of the evaluator and stakeholders. Evergreen (2014) explains that effective data visualizations can save the cognitive energy of the viewers to focus more on the data and consequently increase their understanding of the data rather than wasting this energy trying to understand this unfamiliar type of visualization. However, the body of research on data visualization in the evaluation context remains limited, as does our knowledge about the impacts of data visualizations on evaluation use (Evergreen, Lyons & Rollison, 2016). The current study responds to this identified need by exploring the ways that data visualizations in the form of a data dashboard can contribute to evaluation use. For this, it is important to understand what a data dashboard is and how it works.

Data dashboards. Data dashboards have been identified in the evaluation research as tools to monitor, analyse, and present data more effectively (Smith, 2013; Fetterman, et al., 2017). By definition, data dashboards are visual representations that display the most important information needed to measure progress toward goals captured on *a single screen* (Few, 2006). The unique feature of data dashboards is the possibility of featuring dense amounts of data clearly and concisely (Smith, 2013). Within organizations, data dashboards can be used to inform strategic decision-making, the analysis of progress toward organizational goals, or to monitor operational progress toward goals (Smith, 2013). Strategic data dashboards are used for management purposes and they show the progress of organizations or programs over time. These are usually refreshed monthly or quarterly (Few, 2006). Analytical data dashboards are mainly used by analysts, researchers, and evaluators to help them explore and present data to organisational decision-makers (Smith, 2013). The last type is the operational data dashboard, which “keep a finger on the pulse of activities and events that are in constant flux and may

require attention and response at any given moment” (Smith, 2013, p.27). This type of data dashboard is refreshed every minute. The process of data dashboard designing is called “dashboarding” as Smith (2013) calls it. This process according to Smith (2013) has six steps: (1) layout of the screen view; (2) building a dashboard using software of choice; (3) populating the dashboard with baseline data; (4) publishing the dashboard for use by stakeholders; (5) refreshing the dashboard with new data, which is followed by publishing again at an agreed-upon interval; and (6) evaluating and refining the dashboard. Given the contextual constraints reviewed below, the current project focuses on the use of a data dashboard for strategic and analytical purposes using data collected over 12 months by a knowledge network as part of their internal evaluation processes.

Knowledge Networks

The knowledge network in this research project is the Centre for Research on Educational and Community Services (CRECS). ¹This bi-faculty research center at University of Ottawa is focused on research, evaluation, and training. Its mission is to collaborate nationally and internationally with community partners to produce new knowledge and mobilize existing knowledge in order to enhance policies, programs, and practices in education, social services, and health. To accomplish this mission, CRECS has five guiding principles: 1) Social betterment, 2) Inclusion, 3) Collaboration, 4) Crossing boundaries, 5) Integrity. CRECS’ ultimate goal is social betterment, and this mission is built on three main pillars: research and knowledge mobilization, community engagement, and training and capacity building. CRECS activities emphasize inclusion of the marginalized, collaboration with different community partners, and ensuring working beyond institutional and sectoral boundaries, all of this is pursued with respect

¹ Permission has been obtained to use the organization’s real name.

for their partner and with academic rigor. These activities are like events, training sessions, Ten-Minute videos, newsletter, in addition to active virtual presence. CRECS has two co-directors, anglophone and francophone, to promote bilingualism. The co-directors work closely with a management committee to work on planning and decision making within CRECS. It also has senior researchers who participate in CRECS activities, research, and grants.

Knowledge networks are defined by Wenger, Trayner, and Laet (2011) as a group of connections among people to share resources with the goal of spreading knowledge that address current problems in addition to expanding these connections. Knowledge mobilization represented by knowledge networks is meant to bridge the gap between research, policy, and practice (Cooper & Levin, 2010), in other words it is the utilization of knowledge to reach goals in different areas (Gaudet, 2013). Therefore, knowledge networks facilitate learning, knowledge creation and mobilization (Wenger et al. 2011). Nowadays, there is a growing interest in knowledge networks given that they offer new ways of collaboration (McKellar, et al., 2014). However, with all the mentioned potentials of knowledge networks, there is limited research to clarify and evaluate how they work (McKellar et al., 2014). Despite the efforts to evaluate and understand knowledge networks, there are still issues that are not clear and evaluation questions that are not answered (McKellar et al., 2014). Some of these evaluation questions are highlighted by Parkes, Charron, and Sanchez (2012) such as, “would we do differently or not as well in the absence of collaboration?” and “what factors contribute to successful knowledge exchange?” (p.385). Answering these evaluation questions and others will enhance the performance of these knowledge networks. Therefore, program evaluation can be helpful here by providing the appropriate approach and design of assessment and the proper methods and analytical tools to answer these questions (McKellar et al., 2014). Thus, the role of data dashboards in this case

could be to help summarize and visualize the data that answer these evaluation questions on a single screen that is accessed by all relevant stakeholders showing them where they stand and what they need to do to reach their goals.

Research Questions

This study is divided into three phases: (a) collecting and analyzing CRECS data (b) data dashboard design using CRECS data and (c) checking the impact of the data dashboard on evaluation use. Given the paucity of research that might enable the evaluation community to understand how a data dashboard might be designed and developed in ways that support evaluation use, or evaluation processes, the first part of my study describes the design of the data dashboard. The second phase of my study provides an analysis of the perceptions of the usefulness of the data dashboard, as reported by key management stakeholders in the CRECS knowledge network. In addition, since the study intends to examine the impacts of data dashboards on knowledge network's stakeholders and the manifestation of the evaluation use, the study will examine three main parts: stakeholders' understanding of the findings, decision makers' perceptions of the data dashboard uses, and its limitations. The research questions that the proposed research study will explore are therefore:

1. What is the process of creating a data dashboard for a knowledge network?
2. What are the decision makers' perceptions of the effectiveness of the data dashboard design?
3. To what extent, if at all, does a data visualization / data dashboard enable key network stakeholders to understand the network's progress toward key goals?

4. How do participants describe the uses and limitations of the strategic data dashboard in relation to their roles in the knowledge network? Which type of evaluation use does it relate to?

Theoretical Framework

Cognitive and Multimedia Theories

Human brains are adapted to process information (Mayer, 2008). Eyes and ears are the gates through which information pass and then cognitive processes take place to manipulate information and carry out actions (Mayer, 2008). Generally, learners have a limited capacity for processing information in working memory that people are able to attend to only a few pieces of information (5 to 7 elements) and are able to manipulate less elements (Miller, 1956; Cowan, 2016). Cognitive tools like maps, diagrams, and pictures, however, complement memory constraints (Myatt & Johnson, 2011) as they are able to provide dense amounts of data in one visualization that is easier for the brain to process. Since the focus here is on data dashboards and representation of data using visuals and text, using data dashboards can be referred to as multimedia learning. Multimedia learning is referred to as the ability to learn from multiple representations, specifically verbal and visual representations; “learning from words and pictures” (Mayer & Moreno, 2003, p.43). This raises several questions: how and why these external representations help to extend our mental capacities and what the principles of multimedia learning are. Two relevant cognitive theories in this context can provide legitimate explanation, which are dual-coding and multimodality.

Dual coding theory by Paivio (1986) explains that the human cognition has two subsystems that process information which he called “imagery system” and “verbal system” that are assumed to have different structures and functions. The assumption is that text is processed only through verbal systems while pictures get processed through both the verbal and visual systems (Mayer, 2009). Due to the duality of pictures processing, learners are expected to recall pictures more easily than text (Paivio, 1986). Moreover, Mayer (2009) explains the *multimedia*

principle that people learn more deeply from words and pictures than from words alone. Mayer (2009) highlights that only 10 percent of verbal information is retained after about 48 hours. He adds that when visuals and graphics are added to the explanation, retention increases to 75 percent. Therefore, visualizations are assumed to build stronger cognitive paths that would enhance understanding. It is also necessary for successful multimedia learning to understand that people also learn better, when corresponding printed words and pictures are placed near rather than far from each other on the page or screen and simultaneously rather than successively (Mayer, 2009; Sweller, Chandler, Tierney & Cooper, 1990). Thus, this type of integrated multimedia eases the cognitive load resulting from information from multiple sources (Ayres & Sweller, 2014).

Similar to the theory of dual channels is the theory of multimodality, which refers to any form of communication that employs more than one mode or system to convey meaning. Kress (2010) explains that “social-semiotic theory is interested in meaning, in all its forms” (p.54) and that “the core unit of semiotics is the sign, and signs exist in all modes” (p.54). Mode is central to multimodality, it includes verbal, written, visual, audio resources for communication (Jewitt & Kress, 2010). Multimodality suggests that learning through multiple modes — image, action, and/or linguistic resources — does far more than illustrate the meanings realized through speech or written language alone (Jewitt, Kress, Ogborn & Tsatsarelis, 2001). In the end, dual coding theory and multimodality theory suggest that information should be presented using multiple modes that are presented close together to alleviate the burden on the memory and maximize brain powers for better understanding and acquisition of knowledge.

Theory of Power and Empowerment

Looping back to evaluation use, the sociological theories on organizational behavior can be of interest here. Thompson (2003) explains that uncertainty is a major problem for organizations; they need to understand how to plan for uncertain futures as a way to enhance their performance. Evaluations can help to ground decisions in evidence and empower better decision-making in the face of uncertainty. Patton (2015) asserts that “the power of evaluation varies directly with the degree to which the findings reduce the uncertainty of action for specific stakeholders” (p.460). Patton (2015), based on Thompson’s theory, explains that evaluations are likely to be used when stakeholders feel they are involved and own the evaluation process and findings. Therefore, evaluations should present data that are relevant and, in a form, understandable by the stakeholders (Thompson, 2003).

Moreover, empowerment theory is one of the influences for creating this data dashboard. Empowerment theory is about gaining control, obtaining resources, and understanding one’s social environment (Fetterman et al., 2017). Data dashboards help linking the activities done within the network to the outcomes, which helps in drawing causal relationships or at least a chain of reasoning (Fetterman et al., 2017). This enables stakeholders to determine the logic behind their actions. Based on this theory, it is expected that the use of data dashboards will cultivate ownership and ultimately evaluation use. To conclude, both theories suggest that providing relevant data to ‘organizations’ will empower them to make logical, evidence-based decisions.

Guiding Principles of Data dashboard Design

The design of CRECS data dashboard is based on Few’s (2006; 2012) principles. Guided by the limited cognitive capabilities of the human brain, Few (2006; 2012) lists 13 mistakes to be

avoided in the design of any data dashboard in order to reach the maximum benefit of it and enable the brain to process information in the fastest and most effective way. A summary of the thirteen common mistakes in data dashboard design and a brief explanation is presented in table 1.

Table 1

Few's 13 Mistakes to be avoided in Data Dashboards

Mistake	Explanation
1. Exceeding the boundaries of a single screen	All the data are within the eye span with no scrolling.
2. Supplying inadequate context for the data	Contextual information that would enrich understanding (compared to what? Or how good or bad?)
3. Displaying excessive detail or precision	Providing unnecessary details that adds burden on the brain.
4. Expressing measures indirectly	Being unclear about the message and using measure ineffectively to show this message.
5. Choosing inappropriate display media	Using graphs that do not match the measures and the message.
6. Introducing meaningless variety	Variety should not be the aim in a data dashboard.
7. Using poorly designed display media	Colours, fonts, legends, lines, and gridlines should be used properly following visualization guidelines.
8. Encoding quantitative data inaccurately	Using the right scales and axis
9. Arranging information poorly	Information should be organized according to importance from left to right. Information should be segregated into meaningful groups.
10. Highlighting important information ineffectively or not at all	Information that need immediate action should be highlighted properly.

11. Cluttering the display with visual effects	Simplicity is key and visual effects should be used only if needed.
12. Misusing or overusing color	Use cool colors and keep bright ones to highlight only important data.
13. Designing an unattractive visual display	

(Few, 2013, P.35)

Next, I describe the methods I used through each phase of my research project.

Methods

Research Design

In this section, I describe my methods of data collection and analysis for this study that took place at CRECS, uOttawa. It is important here to clarify the different stages of this research study since it included multiple phases of data collection and analyses. In Figure 3, I show how the project progressed through the initial collection and analysis of data provided by the University Knowledge Network to the development of the data dashboard and finally through interviews with the primary intended users about the data dashboard and its uses. To answer each research question, I have used several methods of data collection and analysis, as shown in table 2.

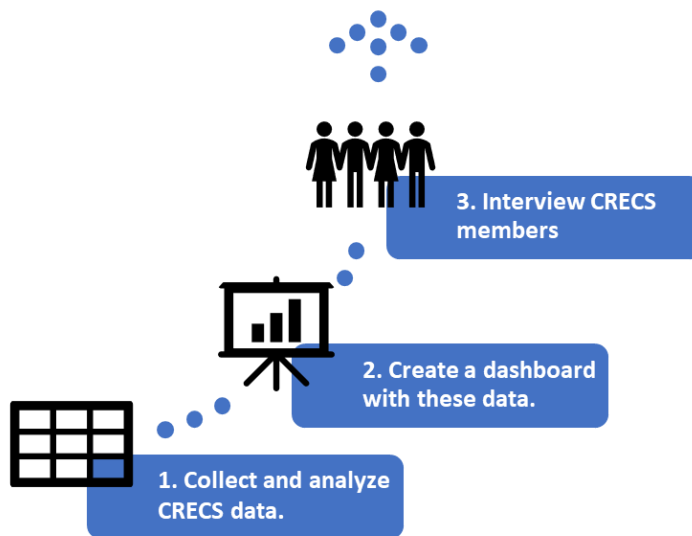


Figure 3. Phases of this research project.

Table 2

Research Phases, Research Questions, and Methods

Research Question	Data Collection Phase	Collected Data	Data Analysis Phase	Types of Analysis
RQ1: What is the process of creating a data dashboard for a knowledge network?	Phase 1: Gather CRECS data	Phase 1: CRECS document, Twitter data, Google Analytics (see table 2 for detailed list of documents)	Phase 1: Analysis of CRECS data	Phase 1: Basic descriptive methods
	Phase 2: Design Data dashboard	Phase 2: documentation of the process	Phase 2: Analysis of data dashboard design	Phase 2: Explanation of design decisions
RQ2: What are the decision makers' perceptions of the effectiveness of the data dashboard design?	Phase 3: Interviewing CRECS management committee members	Phase 3: Participants' perceptions of data dashboard design and use.	Phase 3: Analysis of interviews	Phase 3: Thematic analysis
RQ3: To what extent, if at all, does a data dashboard enable key network stakeholders to understand the network's progress toward key goals?				
RQ4: How do participants describe the uses and limitations of the data dashboard in relation to their roles in the knowledge network? Which type of evaluation use does it relate to?				

Research Participants and Setting

The study took place in CRECS at University of Ottawa. As part of its regular operations, CRECS evaluates its performance and progress towards strategic goals. In its evaluation process, CRECS has a logic model and its management committee has drafted a strategic plan and identified key performance indicators to monitor CRECS progress towards its goals. CRECS was chosen for three reasons: 1) I was familiar with the organization and its director, 2) they had a logic model and they were in the process of evaluation, and 3) they expressed their interest to incorporate a data dashboard as part of their evaluation process.

CRECS is a bi-faculty research center that involves various stakeholders: administrative team, management committee, senior researchers, students, and community partners. Yet, this study includes only the management committee, although CRECS management committee are not the whole network, they are identified as the primary intended users of the evaluation and the data dashboard and the key decision makers in the network. The data dashboard is considered as an evaluation exercise within the evaluation process; therefore, it follows the same rules of program evaluation of depth and breadth of engagement of stakeholders (Taut, 2008) who can be classified into three types: 1) primary intended users, 2) secondary stakeholders, and 3) tertiary stakeholders. Since it is a strategic data dashboard that is intended to be for management purposes, the study intentionally included the management committee as the primary intended users of the program evaluation and the data dashboard. The decision of participants' selection was taken in consultation with CRECS co-director and another member in the management committee because it is considered as an evaluation exercise as mentioned earlier. During the same discussion, there was also interest in including the voices of the students who have been actively involved in CRECS activities. The intention was to invite

two research assistants, but by the time of data collection one of them has already finished and left CRECS. Therefore, one research assistant was invited to participate in the study as well. The management committee has 9 members (n=9), and one research assistant (n=1). Recruitment emails were sent to all the mentioned members; six members responded to the invitation and participated in the study (n=6). Through a Doodle poll, a focus group was scheduled where four members were able to participate. To accommodate the other two members who were still interested in sharing their thoughts, I conducted two individual interviews to accommodate their tight schedules. The total number of participants was therefore six including the research assistant.

The Researcher

I come to this research as a qualitative educational researcher whose background was in teaching. As a teacher, I was used to trying new tools and collect opinions from students. I developed special interest in providing students with overviews and summaries in the most appealing visual way. As I shifted to program evaluation, the same idea of presenting findings and data in the most summarized yet informative way is of great interest to me. Therefore, my bias comes from my perception of how useful these tools can be. The other thing is that I am the designer of this data dashboard, so there might be another source of bias since it is considered my creation and belongs to me. However, during these interviews, I was very aware of these sources of bias and I kept them at minimum inviting participants to express openly how they used this data dashboard and their critique was very welcomed and considered.

Methods of Data Collection and Analysis

Methods of data collection and analysis during phases 1 and 2 address the first research question that is on the process of creating a data dashboard for a knowledge network. Phase 3 of

the project focuses on research questions 2, 3 and 4 which focus on the participants' perceptions of the data dashboard uses and limitations. There is a tension in the methods for this research project because the first question is about design process. For this research question, the methods are also results because the description of the data dashboard design process are the data needed to answer this question. For this reason, I provide only a brief description of my methods of data collection and analysis here, whereas the results section includes a detailed description of the design thinking and decisions I made with each data source in order to create the data dashboard.

Phase 1 methods of data collection and analysis. To gather the necessary data for the creation of the data dashboard, permission was obtained from the CRECS directors to use CRECS data to populate the data dashboard and visualize CRECS key performance indicators. This permission granted access to CRECS documents, Twitter account, and Google Analytics. The decisions about data prioritization were taken in collaboration with the primary intended users. In this participatory process, I had discussions with the co-director and another member in the management committee about which data to include, based on their priorities as a management committee. I was also guided by the CRECS logic model and strategic plan, which have the indicators that reflect the network's performance. I then created a document that lists these indicators and the documents that will inform these indicators. This document was shared with the co-director and a member in the management committee for their approval. Once gathered, these data were analysed using basic descriptive methods (e.g., frequencies) and basic categorizations (e.g., types of research projects conducted by researchers). The full documentation of the process of data collection is reported in Results.

Phase 2 methods of data collection and analysis. The data dashboard was developed with Tableau++ software, and in accordance with the principles of data dashboard design

outlined by Few (2013). Several prototypes were developed using the data gathered in Phase 1. The design was informed by the input of the primary intended users in two instances: 1) I consulted the co-director and 2) I showed the data dashboard to the whole management committee during one of their regular meetings. The final version of the data dashboard was based on the input of the primary intended users on these two occasions. In the results section, I provide a detailed account of the feedback I used to inform design iterations until I settled on a final version for use during Phase 3.

Phase 3 methods of data collection and analysis. The third phase of data collection and the main purpose of this study is exploring the impact of this data dashboard on evaluation use. To address research questions 2,3, and 4, qualitative methods of data collection and analysis were used (Miles, Huberman, & Saldaña, 2014). Due to the collaborative nature of decision making in CRECS, a focus group interview was conducted to collect members' views. In order to accommodate other members' schedules, I also conducted one-on-one semi-structured interviews with the rest of the members who were interested to participate in the study but unable to participate in the focus group. So, one focus group with three members of the management committee and one research assistant took place and followed by two individual interviews with two other members. Before starting the interviews/ focus group, I gave a brief presentation on the project, data dashboards in general, and the contents of the CRECS data dashboard. Participants were then given 15 minutes to review the data dashboard and allowed time to think about its content. It is worth mentioning here that this was the second time for the participants to see the dashboard, as it was presented to them during one of the regular meetings, however it was the first time for them to see it in its final version. The focus group and one of the interviews took place in person and video-recorded using a DSLR camera and tripod, while the second

interview was conducted virtually using the Zoom videoconferencing application and was video-recorded through a feature of the Zoom pro account. Consents were obtained from all members prior to video recording. The purpose of these 20-30-minute interviews were to get the stakeholder's perceptions of this data dashboard, its uses, and limitations. Although individual semi-structured interviews are a strong methodological choice for this purpose because they tend to invite participants to reflect and freely express their insights without too much external framing (Creswell, 2015), I resorted to focus group interviewing to respect the collaborative nature of CRECS management committee. The focus group protocol and interview protocol are included in Appendix. The data collected were stored on the researcher's University of Ottawa Google drive and another backup copy was stored on an external drive. I transcribed each of the conversations and used an inductive approach (Miles, Huberman & Saldaña, 2014) to identify codes, themes and to construct understandings of the ideas expressed by the participants. My coding matrix is included in Appendix.

Results

I have organized the results section by research question so that the connections between each phase of this work, my results, and the research questions are explicit and clear.

RQ1: What is the process of creating a data dashboard for a knowledge network?

The process of creating a data dashboard included the preparation of data for analysis. I have reported this process in the results section because of considerations for replicability of this work. It is important for readers of this work to understand how each type of data were treated and then used.

Phase 1A: Collecting CRECS Data. In order to answer the first research question in this study, the first phase was to collect the data that was to populate the CRECS data dashboard. I had a meeting with the CRECS co-director to explain the research purpose, design, and the idea of a data dashboard. I then had a second meeting with the co-director and a member of the management committee to discuss how I would embark on the project. These meetings were important for the design process because they enabled me (the researcher) and one of the persons most responsible for the strategic direction of the knowledge network (the co-director) to establish an understanding of our respective needs, to identify possible design directions, and to establish an essential rapport on which I depended throughout the design process as I sought feedback on iterations of the data dashboard.

During the first meeting, I was given copies of CRECS logic model and its strategic plan for 2018-2020. The co-director then granted me access to their data drive to access their documents and provided their Google Accounts password and their Twitter Account password. I worked independently and I dived into the data sorting and filtering documents that would provide insights on the defined Key Performance Indicators (KPI) listed in the CRECS strategic plan. I used the files that provided documentation of CRECS activities in 2018 and extracted Twitter and Google Analytics data for the same period. Twitter and Google Analytics data can be extracted in Excel format and then I cleaned, filtered, and compiled all the files in one document to reflect CRECS virtual performance in 2018. The documents that I found were 1) data on CRECS research projects, which included data on the number and research affiliations of the participating CRECS faculty, the title of their projects, amount of funding reported to be supporting CRECS research projects, type of funding (external or internal), and the researchers' projects start and end dates, 2) a document on CRECS faculty publications, 3) a document on

dates and count of CRECS Newsletter, 4) documents on CRECS knowledge mobilization activities (Noon-hour Colloquia, Ten-Minute Videos, Professional Development sessions) and attendance sheets for some of them. I then extracted the following data: 1) Membership survey from Qualtrics, 2) Twitter Analytics, 3) Google Analytics, 4) information on CRECS website that overlap with some of the above-mentioned documents. All these data reflect CRECS performance towards its goals, the three pillars that were mentioned earlier. By analyzing and visualizing these data, CRECS would be able to identify problematic areas in their performance and address them early enough to reach its goals.

Figure 4 shows CRECS logic model that was created as the roadmap for CRECS program evaluation. The highlighted outputs in the logic model are the focus in this study. These outputs represent the results of the activities that CRECS has carried out in order to reach its goals.

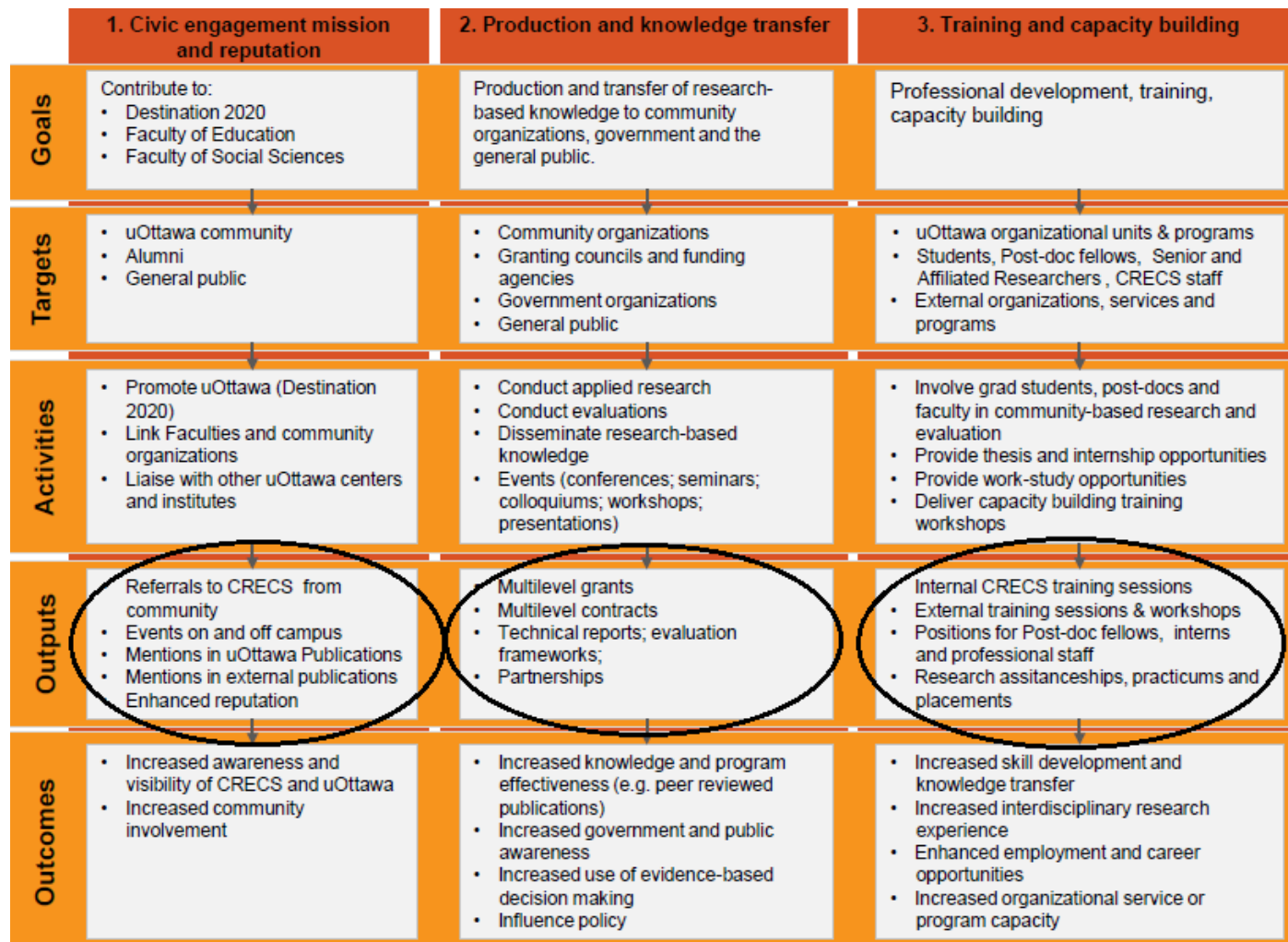


Figure 4. CRECS Logic Model. The focus in this research is on the outputs.

Phase 1B: Preparation of data and analysis. After obtaining the required permissions, CRECS documents were copied into my drive and I created a directory file with documents content and how I will use them (See table 2). I kept the raw files and created another copy from each document to manipulate the data and set it up in the proper way for Tableau++ to analyze and visualize them. Using the software, I calculated descriptive statistics such as sums, frequencies, and averages for the key performance indicators that are based on the outputs

highlighted in CRECS logic model in Figure 4: funding, publications, research projects, virtual performance, knowledge mobilization events, and membership survey. For each type of data, I provide a description of how the data were analysed. The results of these analyses appear in the final version of the data dashboard, presented in Figure 6.

Funding. First, I calculated the funding and categorized it into internal and external funding from the first document that is on CRECS research projects. Afterwards, I wanted to show the different themes of their research projects and the faculty involved in them because research diversity is one of CRECS main goals. In order to create the projects' themes, I used the research projects' titles to create the broad categories (e.g. program evaluation, psychology, etc.) and then I created subcategories to clarify the topic of the research project (e.g. indigenous communities). In this step, I reconfirmed the categories and the subcategories with my supervisor based on the projects' titles. I then showed them to the co-director who requested a change in one of the projects. Categories are reported below.

Publications. All publications produced by members, and the relevant citations are another important goal to CRECS. I used the publications document that I found on their drive and compared it to what is available on their website. Then to make sure that all their publications were included, I used Google Scholar to get CRECS researchers' publications in 2018 and the number of citations for each article. I divided the publications into peer-reviewed articles, books, and project reports and I showed the number of publications under each category then added up all the citations for all the publications together. As for the knowledge mobilization activities, I found multiple documents for each event/session and multiple attendance sheets, so I compiled all the events/sessions in one Excel sheet along with the number of attendees in each event/session. I compared the events/sessions with the ones published on

CRECS website, but I found that some of them were missing on the website. However, I decided to keep the extra events that I found in the documents. It is also worth noting here that I could not find attendance sheets for all the events/sessions. The other knowledge mobilization activity is the Ten-Minute Videos, I found a list of the videos in an Excel sheet and then I compared it to the available videos on CRECS Youtube channel. I was then able to get the reach of each video published in 2018 based on the number of views that appeared on Youtube and I showed the number of views collectively.

Virtual performance. Another important component in the data dashboard is CRECS virtual performance, so I used the data that I pulled out of Twitter and Google Analytics. As for the Twitter account, Twitter provides its users with analytics to help them understand how the content they share on Twitter grows their business. Moreover, Twitter data can be analyzed by looking at Twitter Analytics (TA), which provide different levels of analyzing the data, which are descriptive analytics (DA), content analytics (CA), and network analytics (NA) (Chae, 2015; Bruns & Steiglitz, 2013). Descriptive analysis of Twitter refers to information about the number of followers, hashtags, and users' information (Chae, 2015). I was also able to visualize number of followers per month in 2018 and the increase of followers in 2018. I then visualized the number of tweets, retweets, and most importantly the engagement rate with the tweets that is calculated automatically in Twitter. As for Google Analytics, I used the available calculations that Google Analytics provide to its users which are pageviews, average session by user, average session duration, and the bounce rate, which is when a user opens a single page on a site and then exits without triggering any other requests to the Analytics server during that session. These metrics allow us to judge CRECS performance virtually and how engaged its users are.

Membership survey. The last piece of information on the data dashboard was the responses of CRECS researchers to the questions in the membership survey that was distributed via Qualtrics. The survey data were extracted and summarized in an Excel sheet to get it ready for further calculations and visualization in Tableau. I divided the responses into responses by principal researchers and affiliate researchers, based on how the researcher identifies himself/herself in the first question in the survey. I calculated then the number of principal researchers and affiliate researchers and how many responded with yes to each of the questions. The survey also included data on the number of students that the faculty member supervises and in which level of postgraduate studies. I showed the number of students according to their level of study (See Figure 7 for CRECS final data dashboard).

Table 3

CRECS Documents and Their Uses

CRECS Document	Document Use	Alignment with CRECS Key Performance Indicators
1. CRECS Research Projects Report	<ul style="list-style-type: none"> • Calculate received funding in 2018. • Categorize funding into internal and external funding. 	Funding and financial sustainability.
2. CRECS Research Projects Report	<ul style="list-style-type: none"> • Create research themes based on research titles. 	<ul style="list-style-type: none"> • Research diversity. • Increased interdisciplinary research experience.

3. CRECS Publications	<ul style="list-style-type: none"> • # and type of publications in 2018. • Used Google Scholar to get citations. 	<ul style="list-style-type: none"> • Knowledge mobilization. • Increased knowledge and program effectiveness.
4. Noon-hour Colloquia events and attendance sheets	<ul style="list-style-type: none"> • # of events in 2018 • # of attendees in 2018 	<ul style="list-style-type: none"> • Knowledge mobilization. • CRECS services and activities. • Increased skill development and knowledge transfer.
5. Ten-Minute Video on CRECS Youtube Channel	<ul style="list-style-type: none"> • # of videos in 2018 • # of views 	<ul style="list-style-type: none"> • Knowledge mobilization. • CRECS services and activities. • Increased skill development and knowledge transfer.
6. CRECS Professional training sessions	<ul style="list-style-type: none"> • # of events in 2018 • # attendees 	<ul style="list-style-type: none"> • CRECS services and activities. • Increased skill development and knowledge transfer.
7. Twitter Analytics	<ul style="list-style-type: none"> • # tweets, # retweets, engagement rate in 2018. 	<p>CRECS Visibility and virtual performance.</p>

8. Google Analytics	<ul style="list-style-type: none"> • pageviews, average session by user, average session duration, and the bounce rate in 2018. 	CRECS visibility and virtual performance.
9. Membership survey (Qualtrics)	<ul style="list-style-type: none"> • Members engagement in CRECS activities. 	Co-director's request.

Phase 2A: Creating the data dashboard. The second step to answer the first research question is creating the data dashboard. Earlier in this paper, the benefits and challenges of data visualization were discussed. To avoid the common challenge of poor design of visualizations (Few, 2013), I depended on the foundations of data visualization explained by Tufte (1983 ; 2001) and Evergreen (2014) who explain how to choose the right visualization, colors, and fonts to maximize the benefits and ease the cognitive load on the brain, which would lead ultimately to better understanding of the data and better decisions. Based on recommendations from the Evergreen Data Academy, I also learned to create data visualizations using Tableau++ software .The design of the data dashboard was an iterative process (see Figures 5 & 6) that involved consulting the co-director, collecting her feedback, and feeding these comments back to enhance the design. I also consulted an expert in the field on the design and the best ways to enhance it. This expert holds a PhD in program evaluation, is a designer and evaluator, and runs a data academy and a data presentation consulting firm.

To design the data dashboard, I used Tableau++ (Tableau, LLC, 2020) to create the data dashboard in this study. I compared available software for creating data dashboards that do not require advanced knowledge of coding and found that Tableau is commonly used for this purpose. Tableau is also used by researchers in diverse fields to create visualizations and data dashboards in different contexts (e.g. health, education, business, etc.) (e.g. Huber et. al., 2018; Martin & Ndoye, 2016). As a student, I was able to download the Desktop version of Tableau++ with free access for one year, which was enough to create the data dashboard and complete my study. Creating CRECS data dashboard was an iterative process that resulted in multiple versions of the data dashboard before reaching its final shape (see figures 5 and 6). I met once with the co-director to inform the design of the data dashboard and see whether alterations were needed. A second consultation was with the whole management committee team during one of their

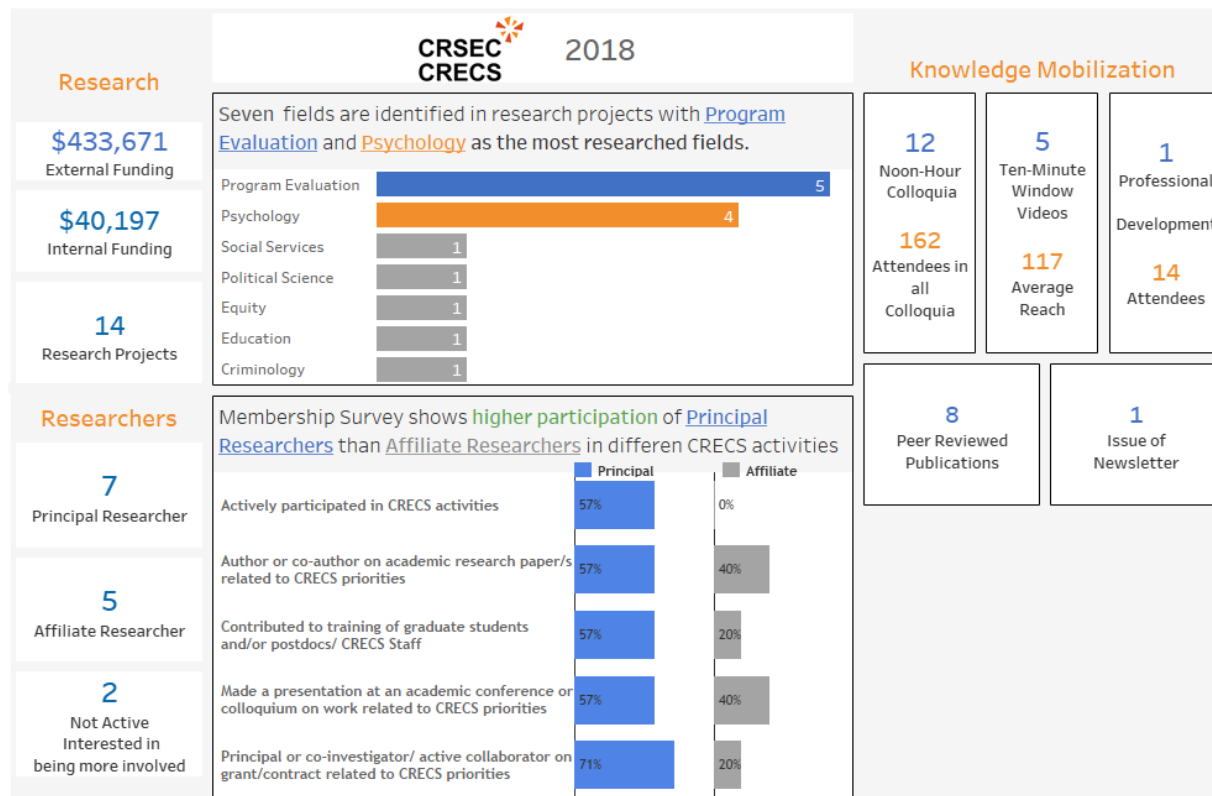


Figure 5. An earlier version of CRECS data dashboard.

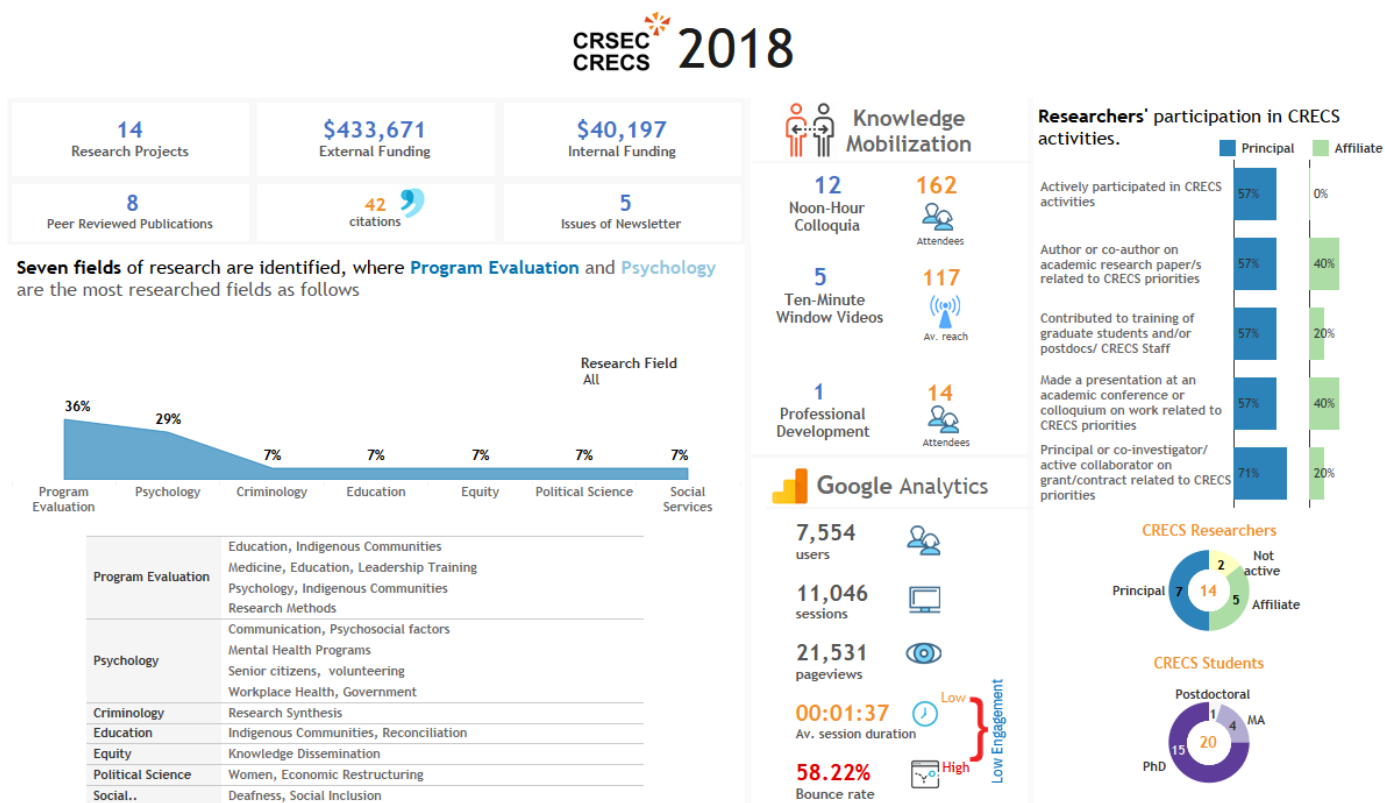


Figure 6. A later version of CRECS data dashboard. In this version an expert in the field suggested changing these abstract numbers into any sort of visualization because the brain is unable to perceive abstract numbers. She also suggested changing the donut chart.

regular meetings to collect their opinion on the design and the data featured in the data dashboard. I also sought recommendations from an expert in the field on the visualizations and their suitability for the type of data they represent. The expert advised to change the abstract number (see figure 6) into any type of visualization because the human brain is unable to perceive abstract numbers in the same effective way as visualizations. She also recommended to change the donut charts (at the bottom right in figure 6) to a bar chart for more clarity (See the changes in figure 7). Although Tableau++ enables its users to share data dashboards on the cloud, I did not use that feature and I only showed CRECS team the data dashboard using a presentation connected to my laptop.

Phase 2B: Analysis of Data dashboard Design. Using Tableau++, I designed the data dashboard for CRECS. There are general rules that I followed in the design of visualizations in general and the data dashboard in particular. For the data dashboard design, I followed Few's (2013) guidelines and avoided the 13 mistakes he advises to be avoided for effective data dashboards (see table 3). Whereas in visualization, I embraced the following rules:

1. Avoid rainbow colours and use no more than five colours (Brewer, 1997). Bright and dark colours require more attention and are visually exhausting, therefore bright colours should be used only to highlight data (Few, 2013). It is better to use soft, semi-saturated colours that are easy on the eyes (Few, 2013). Moreover, data displayed in a data dashboard should stand out against the background, which is achieved through black text and a white background (Few, 2013)
2. Avoid default fonts and use more legible fonts especially on the screen, which are usually referred to as Sans-serif fonts that are straight and clean (Few, 2013; Rello & Baeza-Yates, 2013)
3. Reduce noise in graphs by removing some of the lines (No borders, inside or at the edge of the graph, no tick marks on either axis, no axes lines, Gridlines, in faint grey, along value axes, when not using data labels) (Tufte, 1983 ; 2001).
4. Embed legends when possible (Shah, 1997).

Data dashboard organization. I intentionally divided the data dashboard into three parts with three purposes displaying the most important information on the left to the least important information on the right based on Few's (2006,2013) recommendations on how to organize data in a data dashboard. The three main chunks of information are: 1) research: funding, publications, and themes, 2) Knowledge mobilization: events and virtual performance, and 3)

CRECS membership survey data: members engagement and supervised students by CRECS researchers.

Visualization decisions in each section. The first section, research, begins with the funding, I used the dollar sign and with Tableau, I was able to size the signs to reflect the amount of money so that it is easier for the eyes and the brain to grasp the difference in the amount. For the publications, in an earlier version of the data dashboard, I listed the numbers (see figure 6), but after consulting an expert in the field, she advised avoiding raw numbers and that it is better to visualize them; for the brain takes more time and energy to process raw numbers. Therefore, I used a bar graph for the publications to show in which of the types CRECS is more productive in 2018, and I added the number to the bar graph to save the brain's cognitive energy as well (Shah, 1997). Bar graphs are useful in displaying measures associated with to discrete items in a category along a nominal or ordinal scale (Few, 2013).

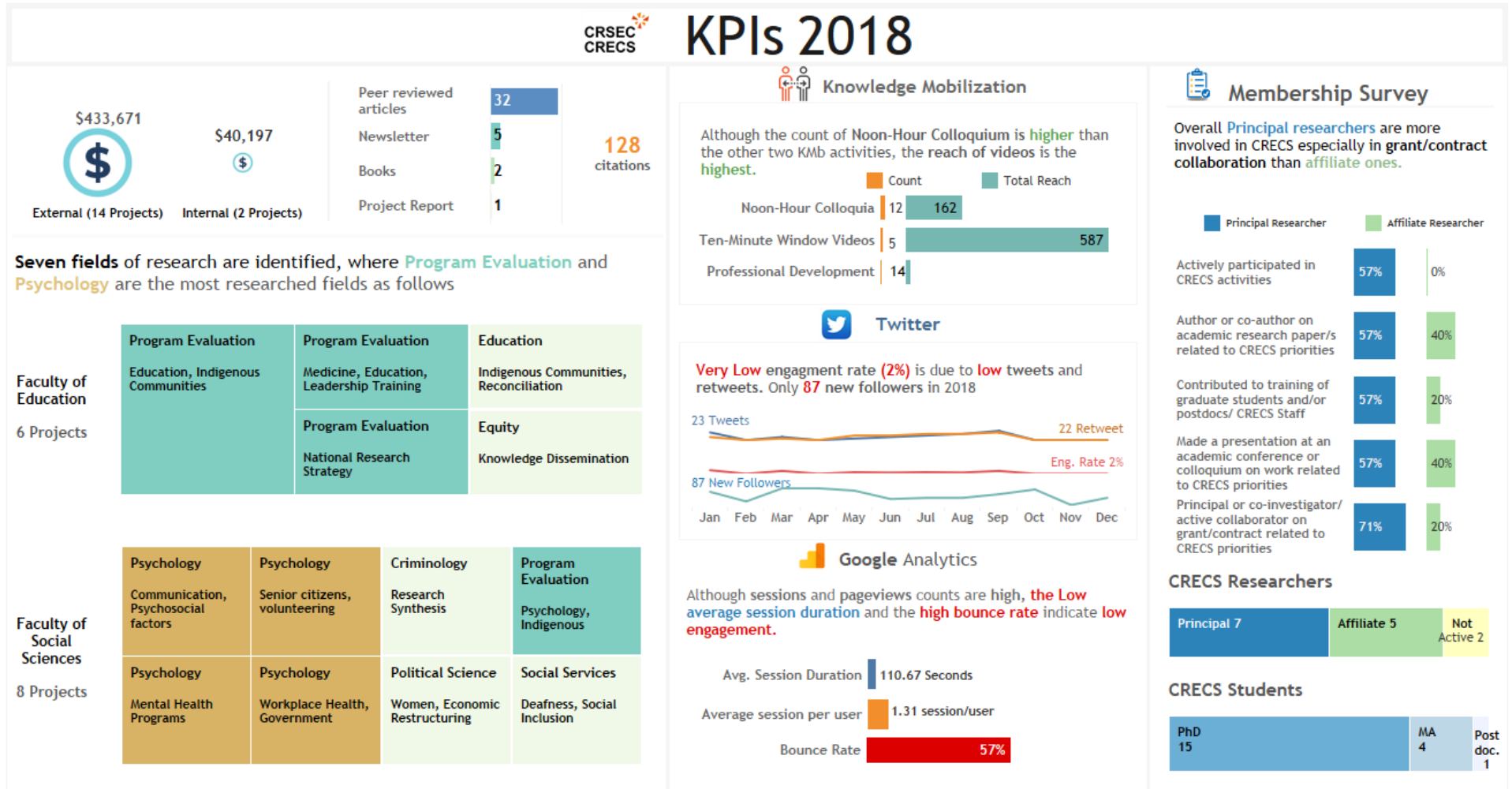


Figure 7. CRECS final data dashboard.

To show the diversity in research themes explored by members of the CRECS knowledge network, I used a treemap graph on the data dashboard that can show the themes' titles clearly. The rectangles in the treemap are sized to encode a quantitative variable. Moreover, colour also encodes the variable and thus provides an even richer display. I divided research projects by the faculty where the research took place and then I emphasized the two most research themes using colours. After plotting the data, I found that the two most researched themes are program evaluation and psychology. I used a diverging colour palette for three classes of data from COLORBREWER 2.0 Color Advice for Cartography. I used the two strong colours for the most researched themes to make them stand out and the third colour for the rest of the themes. I then added a title that summarizes this finding where I coloured the text of theme using the same colours used in the graph below. The title helps with the graph to emphasize the message the data suggests.

The second section is the activities relevant to knowledge mobilization at CRECS. I used a title and an icon that represents the idea of knowledge mobilization where knowledge travels from one to another. Due to the very narrow space, I used the small multiple bars technique to visualize the count of events and the reach, which means the number of attendees or viewers for the virtual content. The small multiple bars are ordered according to the count of events, not the reach. The second chunk of information in this section is Twitter Analytics for which I used Twitter logo to enable spotting the data easily. I used a line graph where I showed the count of follower, tweets, retweets, and engagement rate over the 12 months in 2018. The line graphs enabled presenting a lot of data in one graph, which is important to save space in an already tight space. I embedded legends in the graph instead of the traditional legends on the side to save the brain's cognitive energy trying to match the legend to the graph. Finally, I used a title that

emphasized low performance through the red colour. For Google Analytics, I followed the same design concepts of icons, titles, graph choice, and embedded legends.

The third and last section in the data dashboard is CRECS Membership survey that shows CRECS researchers' types, count, and engagement in CRECS activities. I used the same concepts I followed in the other sections, titles and icon. For the main part that is CRECS researchers' engagement in CRECS activities, I used the small multiple bars to show the difference in engagement between CRECS Principal Researchers and CRECS Affiliate Researchers. The colours of researchers are unified in the first and second graph in the section.

In the previous section, I highlighted the main principles that guided the design of visualizations in general. In table 3, I also summarize how I worked to avoid the 13 most common design mistakes (Few, 2013).

To wrap up, the process of creating the data dashboard for CRECS was an iterative one. It started with making decisions on the data to be included in the data dashboard. This decision was determined by the strategic plan and consultations with some representatives of CRECS management committee. While deciding which data to include, it was also important to prioritize and rank data by importance, which is important for the organization of the data in the data dashboard. The second step was to create a prototype, there were multiple versions of the data dashboard (around 10 versions). This step requires careful consideration of: (a) data organization and (b) data visualization choices. The third step is holding enough consultations with the stakeholders and collect initial feedback on the data dashboard design and data. The final step is incorporating the stakeholders' recommendations to produce the final product.

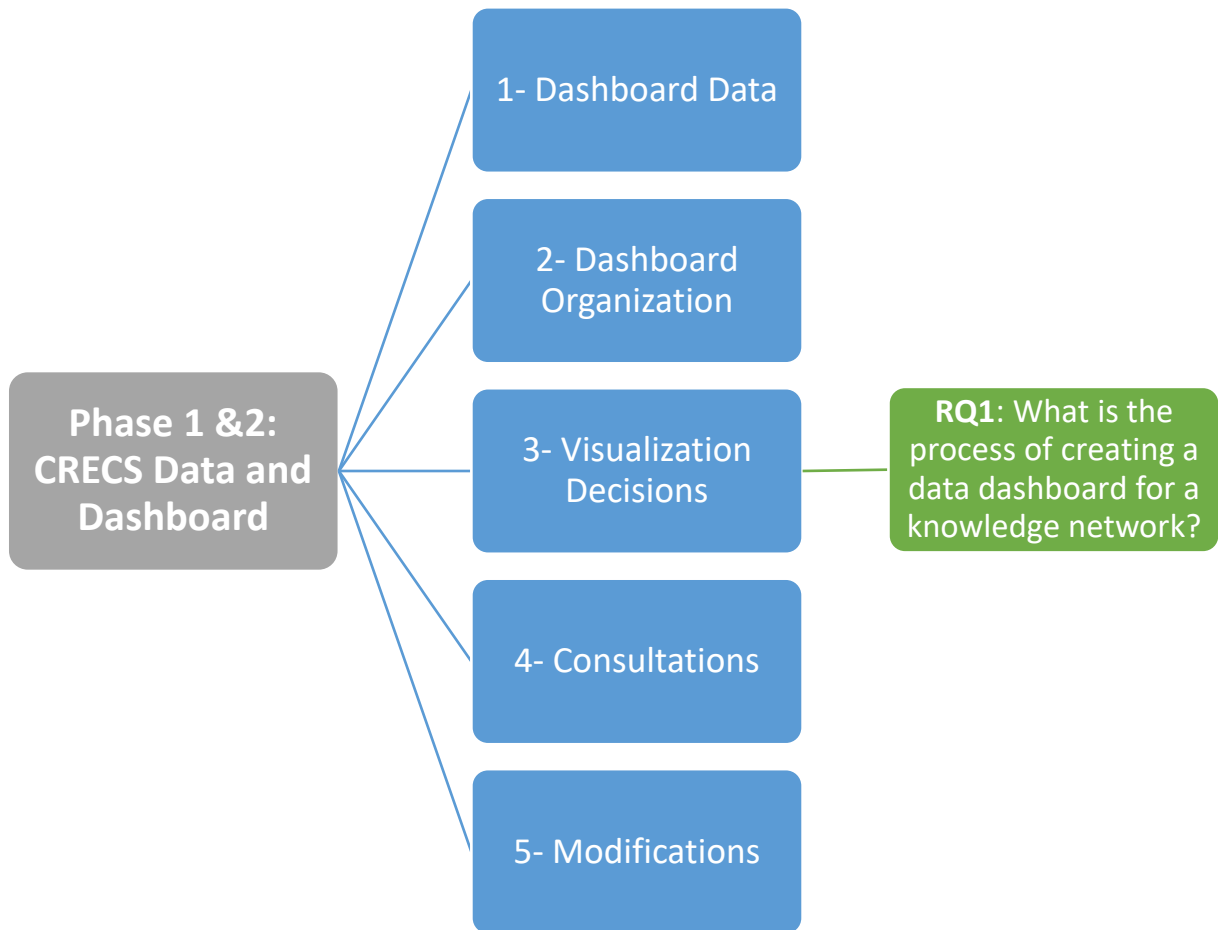


Figure 8. Summary of data dashboard design process.

Table 4

How I Avoided Few's 13 Mistakes in Data Dashboard Design

Mistakes to avoid in data dashboards	Explanation	Avoided	How I avoided them
1. Exceeding the boundaries of a single screen.	All the data are within the eye span with no scrolling.	✓	There is no scrolling up or down for the data dashboard and the visualizations.
2. Supplying inadequate context for the data.	Contextual information that would enrich understanding (compared to what? Or how good or bad?)	✓	I added a title to sections and a sentence that summarizes the finding of the visualization. I highlighted the low performance whenever possible, however some measures lacked basis of comparison.

3. Displaying excessive detail or precision.	Providing unnecessary details that adds burden on the brain.	✓	Numbers were used with adequate precision.
4. Expressing measures indirectly.	Being unclear about the message and using measure ineffectively to show this message.	✓	I used titles that clarify the message of the graph with appropriate measures that matches these messages.
5. Choosing inappropriate display media.	Using graphs that do not match the measures and the message.	✓	I referred to Few's book <i>Show me the numbers</i> to choose the right graphs.
6. Introducing meaningless variety.	Variety should not be the aim in a data dashboard.	✓	I used visualization that are relevant regardless of using the same graph more than once.

7. Using poorly designed display media.	Colours, fonts, legends, lines, and gridlines should be used properly following visualization guidelines.	✓	I followed visualization guidelines mentioned above.
8. Encoding quantitative data inaccurately.	Using the right scales and axis	✓	
9. Arranging information poorly.	Information should be organized according to importance from left to right. Information should be segregated into meaningful groups.	✓	The data dashboard is divided into three sections, where each section has a purpose and a message. The most important piece(s) of information is (are) on the left side of the data dashboard because this is the direction of reading for English speakers.
10. Highlighting important information ineffectively or not at all	Information that need immediate action should be highlighted properly.	✓	I used color coding to highlight areas where low performance is clear and

would require immediate action (e.g. Twitter and Google Analytics).

- | | | | |
|--|--|---|---|
| 11. Cluttering the display with visual effects | Simplicity is key and visual effects should be used only if needed. | ✓ | I did not use any visual effects. |
| 12. Misusing or overusing color | Use cool colors and keep bright ones to highlight only important data. | ✓ | I used a diverging color palette for three classes of data from COLORBREWER 2.0 Color Advice for Cartography. |
| 13. Designing in unattractive visual display | | ✓ | I used simple 2D graphs |
-

Phase 3: Analysis of Interviews Data

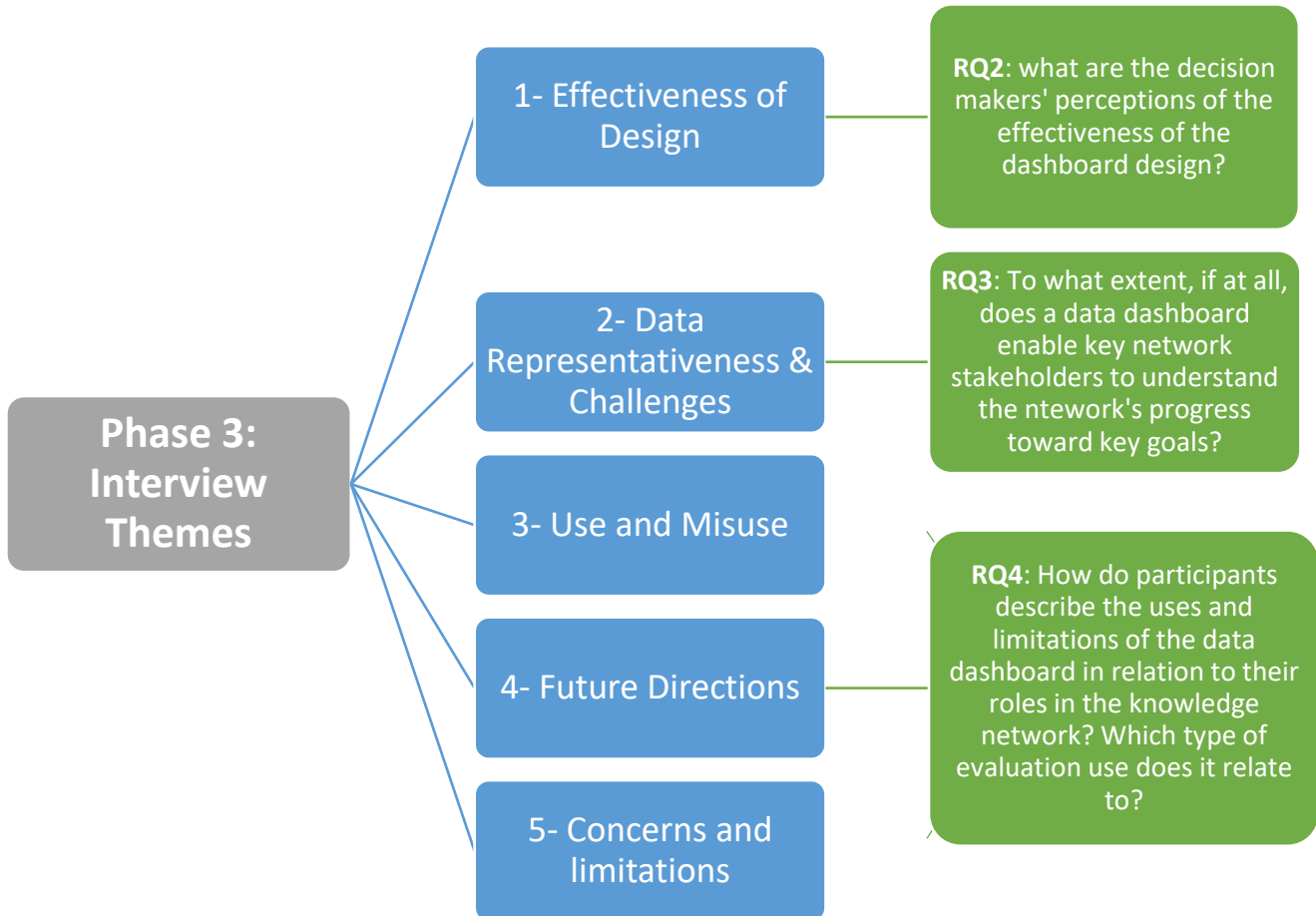


Figure 9. Summary of themes.

Results: Phase 3 to answer RQ 2, 3, & 4. The open coding thematic analysis of the three interviews shows the dominance of five major themes: 1) Effectiveness of design, 2) Data representativeness and challenges, 3) Use and misuse, 4) Future directions, and 5) Concerns and limitations. The five themes align with the four research questions that investigate the effectiveness of the data dashboard design, its uses, and its limitations.

Theme 1: Effectiveness of design.

Exploring participants' perception of the design is to try to understand its effectiveness and is important to enable us to know if the design influences participants' understanding of the data in

the data dashboard and its uses. For this, two of the interview questions were aimed to invite participants' perception of the design: 1) How do you find the data dashboard in terms of design? Please provide your opinion on different components and 2) Do you have any other comments on colour, details, accuracy and adequacy of data, display media, clear arrangement, etc.? Representative excerpts from the interviews are included in table 4. Most participants, however, expressed their satisfaction with the design in general using sentences like "I like it" or "Great". They also expressed their opinions regarding some specific components like font and colour. Most of them (five out of six interviewees) find it visually friendly as they are satisfied with the colours, while some of them (two members) expressed that the font is too small for them to read. Another point that was recurrent is the need for consistency in the way the data are organized, from low to high or vice versa as one participant said, "I would like to see everything either from lowest to highest or from highest to lowest as opposed to it.", and consistency in the use of the red colour to flag data as another participant pointed saying, "is there a possibility the eye might be drawn to where you have used red and away from where you haven't used red. Would you need to be more consistent across all of the content areas to be sure that people didn't overlook something you are using?" Although most of the feedback was positive, one of the participants expressed that it was overwhelming for him as a first reaction as he said, "that is my first observation just when you first showed it to me , when my first reaction is I kinda felt a bit overwhelmed in terms of trying to discern what was being presented". The same participant had also another vision of how items should be organized. They suggested that data should be aligned to match the strategic plan and its structure. This structure depicts CRECS value proposition as three pillars: 1) research/knowledge mobilization, 2) community engagement, and 3) training and capacity building.

Table 5

Effectiveness of Design: Excerpts from Interviews

Code	Definition	Sample data	Theme
PPERCEPTION OF DESIGN	The interviewees negative and positive perceptions of the design in general and of its specific components that range from font, colours, arrangement of items, and use of titles. It is also about their suggestions and questions.	<ul style="list-style-type: none"> • “I like it” • “The colours and the distribution of the images I find it very well done” • “the font is too small” • “it’s sort of just visually for me to see what the chunks of information are that are being presented is more difficult in this particular presentation” • “It’s got a lot of information on one page, which is pretty important” 	Effectiveness of Design

Theme 2: Data representativeness and challenges.

The data in the data dashboard stirred a lot of discussion on the extent to which they are representative of CRECS (see table 5 for excerpts from the interview). These ideas came through this interview question “Does the data dashboard enable you to understand CRECS progress toward the key goals? If yes, how? If no, why not? Can you give a specific example to clarify

your answer?" In general, participants expressed their concerns regarding the quality of the available data and how representative they are of what is really going on in CRECS. The available data in the system that were used to populate this data dashboard are not reliable nor representative of CRECS activities on the ground. In addition, some of the important information like "community partners" was not available in the system, yet it is an important aspect of CRECS mission. Another issue is that the need for some of the data will expire as the membership survey is a one-shot survey and the intention to distribute it again is not clear in the time being. Therefore, one member suggested removing it and adding a short summary of what it communicates and save this space for other important data. On the other hand, participants were concerned with some of the technical aspects of the data dashboard, things like having to update the data dashboard manually and whether data would become outdated over time, were issues that drew their attention. Another important challenge is the possibility of data misinterpretations. A concept like "reach" might be interpreted differently by different people. So, a recommendation suggested was to have cognitive interviewing to make sure that everyone understands the same thing. This suggestion is important if the data dashboard is going to be used in CRECS. In other programs, it would really depend on the nature of the stakeholders, because in CRECS it is a hybrid group from different disciplines which might create this confusion, and the nature of data as well.

Table 6

Data Representativeness and Challenges: Excerpts from Interviews

Code	Definition	Sample data	Theme
Data representativeness & challenges	The code refers to CRECS data included in the data dashboard, its quality, reliability, relevance, and usefulness. It also refers to participants' reactions to the data in the data dashboard. These reactions include both negative and positive ones. It also refers to some of their perceived concerns regarding the data.	<ul style="list-style-type: none"> • “One of the things that I think CRECS prides itself on is engagement with community and this is not evident here at all so we really have to, we’ve got two strategic goals moving forward” • “students, they are mentioned there but not overwhelmingly mentioned” • “you’d wanna have confidence that the data that is being set into a data dashboard like this is reliable. So we wanna get that data collection done properly so that the data is reliable so having a data dashboard and having us being concerned of what is in it is reliable than may be we push ourselves to have better data collection tools than what we currently have.” 	Data representativeness & challenges

Theme 3: Use and misuse.

In general, all participants expressed how they find the data dashboard "super useful". While discussing the possible uses of the data dashboard within CRECS, in this theme we came to three sub ideas: internal use, external use, and misuse of the data dashboard (see table 6 for interview

excerpts). Participants explained that they see the data dashboard as more useful internally. All of them perceive the data dashboard as a monitoring tool that can help them plan their spending and activities early enough, align the indicators to their strategic plan, and monitor the progress towards their key goals. Since the data dashboard is populated by the available data, they were also able to use it to identify weaknesses in their documentation and the implementation of some of their activities like their social media visibility (e.g. Twitter and website). The data dashboard might have a use in the evaluation context as it has the potential to build their evaluation capacity as one member said, "it is developing [their] systems for collecting these data". It might also be useful in the evaluation context if it is relevant to some evaluation questions they have. All of them also suggested using it during meetings to set direction and as one member said to offer a "nice menu" for discussion. It can also be used internally with students affiliated with CRECS to help them understand what CRECS is and help them "create an identity around CRECS". On the other hand, most of them did not see a big use of it outside CRECS; they believe it can be used for reporting but after selecting chunks of data to be reported outside. This brought the idea of possible misuse as one member heavily warned that sharing this tool outside CRECS with this amount of transparency "naively" might backfire and the social system should be carefully considered before taking this crucial decision.

Table 7

Use and Misuse: Excerpts from Interviews

Code	Definition	Sample data	Theme
DATA DASHBOARD USES IN CRECS	The code refers to the suggested uses of the data dashboard internally and externally with different stakeholders for different purposes. It also refers to the concept of misuse of the data dashboard.	<ul style="list-style-type: none"> • “it would probably be the first thing that we talk about each meeting, to kinda get a real sense of where things are at and how things are progressing, and are there any you know risks on the horizon, any crises, budgetary otherwise like those are such questions to me that are really important on a management team, so I can see this thing extremely useful that way” • “you can potentially see the transparency provided by this, symbolically you could hope that the administrators would say we appreciate the transparency we trust you more, but politically what you could see happen is the transparency provided by this would be used against us possibly” • “it shows me more than anything is what we have to work on.” 	Use and Misuse

Theme 4: Future directions.

While some of the members reported that the data dashboard has no effect on the decision-making process, others suggested that the data dashboard drew their attention to the need for better data collection tools (see table 7 for interview excerpts). On the other hand, one organizational leader reported that based on what the data dashboard revealed, they would like the organization to enhance their virtual presence either in Twitter or on the CRECS website, and that they will use a social media grant to enhance that as soon as possible. Moreover, this leader expressed the importance of working to find additional grants to support the dissemination of their work through social media channels. Moreover, this leader explained that the data dashboard would help in the hiring process of a new coordinator for CRECS, as it is important for this new employee to have the required skills to keep their website up to date. In fact, the director expressed the desire to continue to use the data dashboard and keep it up to date for future use. Therefore, it can be concluded that the data dashboard informed decision making, but on the managerial level.

Table 8

Future Directions: Excerpts from Interviews

Code	Definition	Sample data	Theme
FUTURE DIRECTIONS	This code refers to the how CRECS will act in the future upon the findings of this data dashboard	<ul style="list-style-type: none"> • “we push ourselves to have better data collection tools than what we currently have.” • “The partnerships are invisible on our website. Clearly there is something wrong, that doesn’t jump up and it wasn’t even enough 	Future Directions

for you to even record it. So it is clearly unavailable there, it is not obvious to people. So I think that tells us that we have to change our website.”

- “Now one colleague has a grant to enhance Twitter and social media so hopefully we’ll see a difference if we did the same thing next year. We already done little things in relation to it with this colleague taking the social media, we’ve got a grant for that. We are applying for another grant from the same group.”
-

Theme 5: Concerns and limitations.

In the discussion with the different participants several limitations of the data dashboard and concerns regarding its integration came to surface (see table 8). Most members (the four participants in the focus group) saw the requirement to manually update the data dashboard as new data become available to be a big limitation. The absence of automatic updates would result in "opportunity for air not being caught, like the longer the pipeline of your data, the more is missed", as one participant explained. Another concern was the possibility of data misinterpretation by different stakeholders since it is a hybrid group and the way terms are perceived might be different from one group to the other. Two participants suggested carrying out cognitive interviews as a solution.

Moreover, one participant expressed a huge concern regarding the integration of such innovative tools into a social system that might not be ready for this. With all the promise of transparency that data dashboards provide to institutions, there is a huge fear of this to backfire and cause more damage than good, especially in organizations where lack of transparency is “preexisting” . To elaborate, due to the highly political environment of such organizations, CRECS might turn into a “test case” where ratios get calculated based on the data that this data dashboard provides. Then these ratios get “imposed” on other research centers and then the next thing is to set targets and performance indicators to judge CRECS and other similar institutions. As the member puts it " I don't think you are going to that kind of environment naively thinking that you are presenting data and being transparent and therefore we are gonna learn together and focus on that and we have also demonstrated accountability by giving this to you, that's I think that is a very naïve view." He adds that data dashboards are just tools and thorough consideration to the social relationships that surround these tools and how such tools can alter these social relationships in “ways that are unintended.”

Table 9

Concerns & Limitations: Excerpts from Interviews

Code	Definition	Sample data	Theme
CONCERNS AND LIMITATIONS	The code refers to the concerns that the participants expressed regarding the integration of the data dashboard in their system and the	<ul style="list-style-type: none"> • “the other issue too just is not being able to do real time updates but having to input data” • “what’s really important for us both in the short term and the longer term and that we are not kinda led astray or blinded by the 	Concerns and Limitations

limitations of this data	information we have on that data
dashboard as a platform	dashboard and not attending to
for data analysis and	other potentially important
visualization	information that may be in the
	environment.”

Discussion

The purpose of this research was to describe the process of creating a data dashboard for a knowledge network and to explore the use of the data dashboard in the context of evaluation within the knowledge network. Analyses suggest that the process of designing a data dashboard is iterative, and that stakeholders in the knowledge network identified several important insights on the uses of data dashboards for internal and external use. The way I chose to present the ideas in the discussion does not follow the order of the research questions, it rather follows the logic sequence of ideas. I tried to build a narrative that unfolds as the story of a data dashboard in a knowledge network. Therefore, I present the ideas in the following sequence: 1) data dashboard design process, 2) data dashboard design considerations, 3) challenges in design, 4) data dashboard uses in program evaluation, 5) future directions for CRECS, 6) concerns and limitations related to dashboard use.

RQ1: Data Dashboard Design Process

The process of designing the data dashboard in this study included five steps: 1) making decisions about dashboard data, 2) dashboard organization, 3) visualization decisions, 4) consultations and 5) modifications. This process aligns with Smith's (2013) process of "dashboarding". Through careful documentation of each moment in the design process, results show that data dashboard design is iterative. Consultation with users was very important through the design process so that the data dashboard aligned with users' needs in terms of functionality and content. The usability of the dashboard was determined through this iterative, consultative process. Although previous research has shown that the process of design is iterative in other contexts (e.g., Few, 2013; Smith, 2013) the design process of a data dashboard for use by a knowledge network in a university context showed that this process of iterative design can help

to define the structure and content of a living data dashboard that can be used to inform ongoing and changing goals. Further, the iterative process of designing this data dashboard with knowledge network stakeholders allowed them to recognize that the data points included in this version of the data dashboard can change over time, and in relation to their goals.

RQ2: Data Dashboard Design Considerations for a Knowledge Network

Analyses of participants' responses to the data dashboard design showed at least six considerations, each of which have important implications for future research and use of data dashboard visualizations in organizations.

First, participants reported that the CRECS data dashboard helped them get a comprehensive overview of CRECS activities and performance. As one participant said, "I think it is a very one-glance indication of what CRECS is doing". This resonates with the literature that data dashboards can provide a comprehensive overview that enables its users to make quick decisions as having all the information on one screen enhances the cognitive processes and decision making (Few, 2006), which is the case in CRECS data dashboard where all the data were represented within the eye span on a single screen. The other comments on the font and the overwhelming design corresponds with the challenges of design mentioned in the literature as well (Few, 2006; 2013).

Second, other participants indicated the need for consistency in flagging low performance. For data dashboard to be effective, there has to be adequate context that enables users to understand the extent to which this performance is good or bad (Few, 2013). In the CRECS data dashboard, there was, in most of the parts, lack of adequate context because of the absence of a benchmark in the available data that tells the users how good or bad CRECS is doing. Benchmarking was only available in the Google Analytics piece and the Twitter Analytics

that are analysed automatically through both platforms, which made it clear that CRECS virtual presence was clearly low and the engagement rate with their website was significantly low. However, some of the participants reported that the data dashboard can be used as a base of comparison for the coming years, since they do not have a benchmark in the time being, so that they can monitor the increase or decrease of activities in comparison to their performance in 2018.

Consistency in the design itself was another remark of some of the participants. The data were divided into three parts on the data dashboard: two parts had titles and the first part did not have a title. In addition, they requested data organization to be consistent either from higher to lower or vice versa. However, the data were organized the same way in all the sections, so this might suggest the need for creating bigger bars for visual clarity. Yet, the space is very limited to achieve that, which suggests the need to prioritize data to be included in a data dashboard and to only include the pieces of information that are essential to decision making.

Relatedly, most of the members commented on the Membership survey results and that it might not be needed on the data dashboard in the detailed way it was expressed. This remark can be explained through Few's (2013) third mistake that is displaying excessive detail or precision. Although the data dashboard did not display excessive details, it did display unnecessary data, or better phrased, detailed data that will expire soon. Some of the members suggested just hinting to them and use the remaining space there for other pieces of data that were missing once these data are collected and are available to be displayed on the data dashboard. CRECS members used some of their time discussing the benefit of this survey on the data dashboard, which can be considered as a negative consequence of using data ineffectively. This resonates with Few's (2013) explanation of the third mistake, "With a data dashboard, every

unnecessary piece of information results in time wasted as the viewer has to filter out what's important when time is of the essence there's no time to waste" (p.40). Of relevance to the idea of data prioritization were the participants' comments on font size that it was so small for them to read. It is true that the font is small as it was very challenging to fit everything in the data dashboard and maintain a bigger font, so I am aware of this limitation. There should be clear prioritization of data to ensure only the most relevant data are there, so we have enough space to create a more visually friendly data dashboard.

Fourth, one participant expressed being overwhelmed with the data dashboard at first glance. Despite the very comprehensive nature of data dashboards, their design should not overwhelm the viewer/user. This remark might be explained by our limited capacity to process information in the working memory (Miller, 1956; Cowan, 2016) This might suggest that data dashboard designers should be attentive to the chunks of information to not be more than 5-7 chunks. It might also reveal that multimodal data, may actually require more cognitive resources to process (Wiley et al., 2014). So, although the learning may be greater, the cognitive load may be higher and therefore, for someone new to the data dashboard, it may be overwhelming.

Finally, one participant discussed the way the data are arranged and how it would have been more meaningful if the data were arranged in alignment with the CRECS three pillars. This comment can fall under Few's (2013) ninth mistake, arranging information poorly. Data in a data dashboard should have logical organization that users can grasp right away. However, this comment was from only one member who was involved in the development of the CRECS strategic plan and its three pillars. Their overall impression about the data dashboard was positive. Yet, for CRECS to continue to use the data dashboard, this suggestion should be taken into consideration and opinions from the rest of the committee members should be obtained.

If we return to the principles of design outlined by Few (2006,2013) and connect them to the theories of cognitive load and multimodality that framed the design process, an effective process of designing a dashboard should include close attention to the limited cognitive capabilities of the human brain. Few's recommendations are all based on the premise that the human working memory is very limited and should be optimized through design. Therefore, for a data dashboard to be effective, it has to avoid overwhelming its users and wasting their cognitive energy trying to decipher how and why the data are organized in this way, why these data points were selected, how relevant they are to their goals, or what the graphs are trying to show. Instead, the design should seek to minimize any noise that might affect attention so that data dashboard users can focus on meaning making and drawing conclusions. This noise can also stem from very simple details like colours, lines, fonts, and legends. Moreover, multimodal learning is "a higher-order cognitive process that relies on many subprocesses to be successful" and without proper design this multimodal design can overwhelm its users' cognitive abilities (Wiley et al., 2014), which takes us back to the idea of chunks and limiting the information to only 5-7 chunks of data for better and efficient processing (Miller, 1956; Cowan, 2016).

Based on the above-mentioned considerations, my recommendations for an effective data dashboard are that it should: 1) have clear structure and organization that reflects its users' needs, 2) use a consistent design that include consistent use of titles, colours (e.g. red for low performance in all the data points), and order of data, 3) divide data to 5-7 chunks of the most precise, relevant, and useful data, 4) reduce any noise coming from the design (e.g. avoid rainbow data, embed legends within graphs, and remove all unnecessary lines, like grid lines), and 5) keep the design simple and clean.

RQ1: Challenges in Design

After presenting participants' viewpoints in the design, it is important to explain the challenges I faced as a designer to display all CRECS indicators in the most appealing and effective way. At the outset of the project, I realized the need to learn about effective data visualizations and data dashboards. For this I depended on the books of some of the famous names in the field like Stephen Few, Stephanie Evergreen, and Edward Tufte. I also got enrolled in Evergreen Data Academy, which provides tutorials on effective visualizations using Tableau. Despite the preparation I did, I still grappled with some challenges. First, the size of the data dashboard is very limited to fit everything and according to Few (2006,2013), the unique feature about a data dashboard is that all data are featured on one screen with no scrolling up or down. According to Few (2006) the biggest challenge with creating a data dashboard is fitting everything on a single screen clearly without distraction and in a manner that can be quickly understood. The workaround I did was to decrease the font to be able to fit everything in one screen. Choosing the right graph to communicate the right conclusions in this very limited space was another challenge I faced. I tried multiple graphs and went through many iterations before I settled on the ones I used.

Another level of challenge related to learning how to use the software, namely Tableau. Unfortunately, Tableau is not an intuitive software and is not similar to the other popular data software like Excel. There is a learning curve here and it should not be expected to master it in a few months. One of the Tableau++ challenges was learning how to set up the data in Excel so that Tableau could read the data and analyze them correctly. Creating internal codes for calculations is another big challenge in Tableau and requires massive amounts of time to learn. These were my biggest challenges and it took a considerable amount of time to start to figure out

the right way to use basic functions of Tableau. I created around 12 versions of the data dashboard until it reached its final shape (See Figures 5 & 6). To conclude, with all the benefits of data dashboards and the promise of better understanding and decision making, they require considerable amount of time, money, and skills from an evaluator to be executed successfully.

RQ4: Data dashboard Uses in Evaluation

The fourth research question in this study is concerned with the impact of the data dashboard on the evaluation use and the other possible uses. Participants reported potential uses that are considered hypothetical since the data dashboard was not used during meetings or for prolonged time. These potential uses fall into three types: 1) internal use, 2) external use, and 3) misuse.

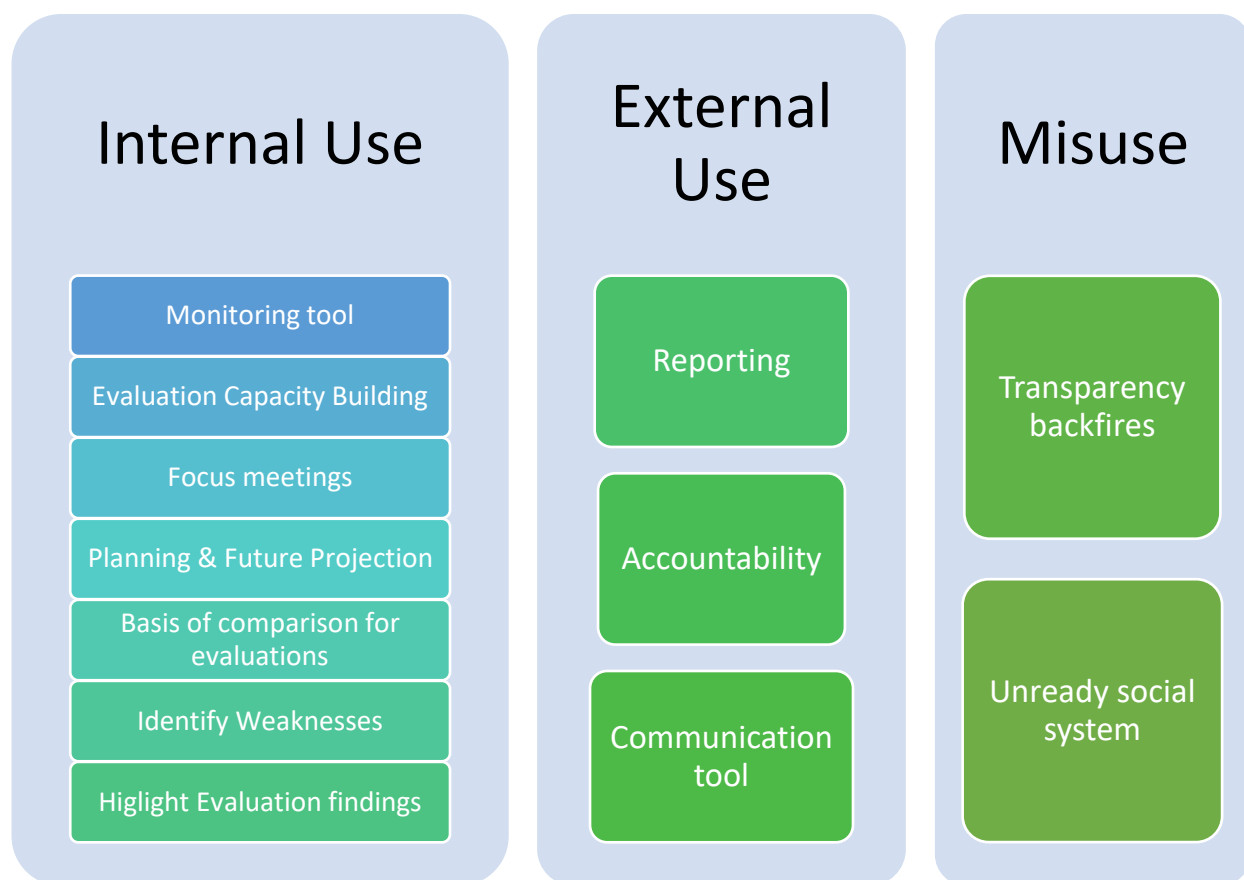


Figure 10. Summary of data dashboard uses.

Internal use.

Participants reported the importance of using the data dashboard to monitor CRECS activities, CRECS progress towards its goals, and identify problems early enough. The data on the data dashboard are based on CRECS indicators listed in the strategic plan. The idea of monitoring performance is not far from program evaluation. Monitoring and Evaluation (M&E) plans are usually developed at the beginning of the program when the interventions are being designed to ensure there is a system in place to monitor the program and evaluate success based on pre-set indicators and evaluation questions. In M&E literature, *Monitoring* is defined as “a continuous function that uses the systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds” (OECD ,2002, p. 27). Therefore, monitoring can provide quantitative and qualitative data using selected indicators, data that can serve as inputs to evaluation exercises. However, monitoring performance and progress does not tell the whole story of why an intervention worked or did not work, which is the essence of program evaluation. Therefore, for a data dashboard to have a direct effect on evaluation use, the data featured should be anchored around the program’s evaluation questions not only the indicators that monitor performance.

Some participants noted that the data dashboard can foster evaluation capacity building within CRECS. That is because, it enhances data collection and data presentation to the stakeholders, as one of the participants said, “It [the data dashboard] could create your evaluation capacity as it is developing your systems for collecting these data”. ECB is defined as “the intentional work to continuously create and sustain overall organizational processes that make quality evaluation and its uses routine” (Stockdill, Baizerman, & Compton, 2002, p. 14). Preskill

(2008) explains the potential of technology as a construct to enhance ECB that “if we design and use technology appropriately within the evaluation profession, it has the potential for contributing to what and how people learn from and about evaluation” (132). One of these uses is to “disseminate and improve access to information” (Preskill, 2008, 132). Aligning with Preskill’s ideas, CRECS data dashboard is viewed by stakeholders as a form of technology that improves access to data and enables more effective ways of data and knowledge dissemination.

Identifying weaknesses was one of the uses participants mentioned. Specifically, CRECS members referred to flaws in CRECS documentation process as the data available are not reflective of CRECS activities on the ground. The ability of the data dashboard to highlight such flaws in data can be seen as a form of evaluability assessment (EA). EA is “The extent to which an activity or project can be evaluated in a reliable and credible fashion” (OECD-DAC 2010; p.21). One of the dimensions of evaluability assessment is the availability of relevant data and the capacity of management systems able to provide it (Davies, 2013). Therefore, EA improves the prospects for an evaluation producing useful results. Considering EA and its uses, CRECS data dashboard helps in assessing CRECS readiness for evaluation and can serve as part of EA as it provided insights about the measures to be taken to ensure tighter documentation of CRECS activities for future evaluations. It is worth mentioning here that EA process results in many benefits like enhancing understanding, reinforcing evaluative thinking, fostering organizational learning and building program’s capacity for evaluations, which can be called process use (Trevisan & Walser, 2017). Based on evidence provided by participants in my study, it seems that a digital data dashboard may be a tool that enables a knowledge network to engage in evaluability assessment (or something similar).

Other potential internal uses of CRECS data dashboard that participants mentioned are focusing meetings, future planning and projection, and identifying weaknesses. These uses can be seen through an organizational lens where theories of power and empowerment are applicable. Thompson (2003) explains that uncertainty is a major problem in organizations, and they need to understand its performance to be able to enhance its future. The CRECS data dashboard enabled its users to reduce the uncertainty about their performance since CRECS has never had this comprehensive data displayed all at once to tell them their story. CRECS members were able to identify weaknesses in their performance and propose actions to resolve the identified weaknesses. Uncertainty can also be a result to lack of data, which is what the data dashboard was able to cover. The data dashboard was able to open the black box of data and present the information about their performance in an insightful, organized, and appealing way. Moreover, empowerment of the CRECS team can be another outcome of this data dashboard. Empowerment theory is about gaining control, obtaining resources, and understanding one's social environment (Fetterman et al., 2017). The data dashboard has the potential to empower CRECS management committee since empowerment is about becoming stronger and more confident as participants reported potential uses like projection and identifying weaknesses. Further, CRECS data dashboard can link the activities done within CRECS to the outcomes, which helps in drawing causal relationships or at least a chain of reasoning (Fetterman et al., 2017) that builds on what the logic model proposes. This enables CRECS members to determine the logic behind their actions.

Further to these internal uses, some members explained that CRECS data dashboard can have potential uses in program evaluation. The data dashboard can be used as a basis of

comparison when the decision is taken to conduct the evaluation. In addition, one participant explained that the data dashboard can be useful if it is tweaked to highlight evaluation findings.

External use and misuse.

On the other hand, participants explained that the data dashboard can have some external uses as well. It can be used as a communication tool with other stakeholders, reporting tool, and for accountability. However, there is a fear of using this data dashboard naively and sharing it outside CRECS; that this level of transparency might backfire and be used against CRECS rather than appreciating this transparency. This suggests that data dashboards can be useful tools for internal use, yet they have to be used with considerable amount of caution outside an organization.

RQ3: Future Directions for CRECS Using Data Dashboard Findings

The process of iteratively designing and then reflecting on the use of the data dashboard and its data were able to guide CRECS in planning for future directions. The data dashboard data highlighted some organizational challenges and flagged some issues in the data collection system. Upon the low virtual visibility, an available grant for social media has been put in effect with the intention to reapply for another grant to boost their virtual visibility. Moreover, these flags influenced hiring criteria for an administrative assistant who was going to be hired soon after these interviews were conducted. Upon the results of the data dashboard, the new administrative assistant needs to be able to manage CRECS website and other social media platforms. These decisions are the result of the monitoring function of the data dashboard that flagged low performance due to insufficient activity and updates on CRECS website. Again, these indicators do not tell why these measures are or are not working, yet they are able to reshape future actions and ultimately would help in program evaluation.

RQ3: Concerns and Limitations Related to Dashboard Use

Some participants expressed concerns over the data dashboard updating mechanism and frequency and the possible problematic impact on decision making. These concerns are legitimate. However the process of updating the data should not be problematic. Once the spreadsheets linked to the data dashboard are set in the right format, it would only take updating these spreadsheets for the data dashboard to be updated automatically. The frequency of updates can be tied to the management committee meetings so that they have the most recent data to review. Another huge concern is the integration of such innovative tools into a social system that might not be ready for this and the possible negative consequences on the center. While these concerns might be true and realistic, the purpose of building this data dashboard was for internal use by CRECS management committee and for program evaluation purposes. Therefore, the fear of transparency to backfire can be avoided by deciding who will see and use the data dashboard, what data will be included in the visualization, and how decisions will be made with the data summarized in the data dashboard.

In sum, for data dashboards to be effective and comprehensive, they must be created in alignment with research on data visualization, and recommendations for how to create a resource that reflects the most important data for the organization and in a way that does not overwhelm. Analyses of participants' perceptions of the data dashboard I designed suggest that data dashboards can be useful in the program evaluation context as monitoring tools, for evaluability assessment, and for evaluation capacity building. For these tools to be used externally, there should be careful consideration of the social system they are integrated into and what impacts these data dashboards can have.

Contribution of the Study

Although Few and others provide valuable recommendations on how to design a data dashboard in general, there is a paucity of published research on the use of data dashboards in program evaluation context. Even less research has focused on evaluations of knowledge networks in general (McKellar et al., 2014). This study addresses both of these needs. It provides new evidence on the potential uses of data dashboards in the context of program evaluation activities with a Knowledge Network. Beyond this study, future research is still needed, however, on how people think of data visualization dashboards and interact with them over time, and in many other aspects of evaluation.

The data dashboard design process outlined in this study will help any other knowledge network because it details how I went about the data collection and analyses and the indicators used in the data dashboard, which can inspire them in the way they design a data dashboard. The data dashboard in this study can provide a model that can inspire them, save them time, and lead them directly to a version that works. I also included the challenges that I faced as an evaluator: the time, resources, and efforts to be able to use the software and develop the data dashboard. Such challenges can provide a realistic view for an organization or an evaluator to decide the feasibility of using these tools and to weigh the benefits against the challenges and decide how they want to proceed.

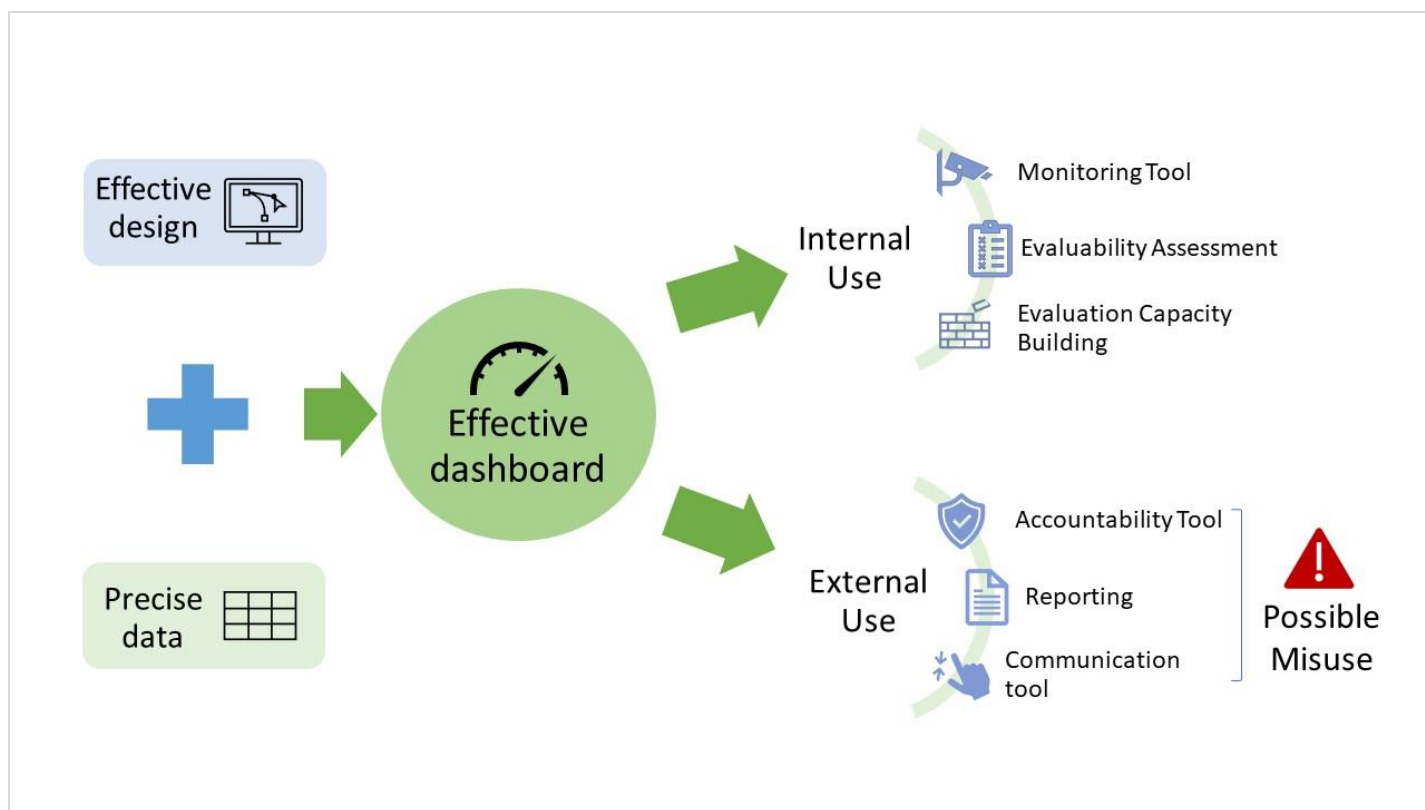


Figure 11. Summary of the research findings

Limitations of the Study

The results of this study suggest several potential uses of the data dashboards in activities relevant to program evaluation. Yet, these uses are not conclusive nor generalizable. Participants of this study were introduced to the data dashboard briefly prior to the interview. Moreover, participants got to see the dashboard only two times for 15 minutes each, so the reported uses are only potential uses that they anticipate. Therefore, for these uses to be confirmed, the data dashboard should be introduced and used for a prolonged period of time, for six months or more (Smith, 2013), and participants should be interviewed for a second time to conclude how the data dashboard has been used. Although the literature identifies the potential of the data dashboard to have interactive features, like hovering and being directed to more details, I could not show the data dashboard to the participants on Tableau and get them experience such interactivity.

Another limitation is that CRECS did not have the capacity to have a dashboard that auto populate data, such data dashboards require servers and special infrastructure. Future research might include technical affordances commonly available through interactive media online such as ways to access expanded information about key performance indicators by hovering over items, or access to video data of relevance.

Moreover, the results are definitely not generalizable since the context here is a research centre with a special culture of decision-making processes and unique relationships among its members. The special nature of CRECS lies in the fact that all participants are advocates of program evaluation and embrace it within CRECS that there is already a solid logic model and key performance indicators identified. This evaluative culture affected how they perceive the data dashboard and made it easier to see potential uses and benefits. The data dashboard helped them reposition themselves to proceed with their goals and their program evaluation plan. CRECS director has also shown interest in continuing to use the dashboard and update it frequently, yet I got a full-time job and could not continue to help them with the data dashboard. Thus, it is unknown how other institutions or programs would perceive the data dashboard given the political nature of program evaluations and the possible resistance inside institutions. On the other hand, decision making processes within CRECS are collaborative with a lot of harmony among its members, which again makes it easier to welcome such new tools as data dashboards and see their potential to set the direction during meetings and beyond meetings as well. Therefore, further exploration of the insertion of these data dashboards within different environments with different dynamics is key to confirm the above-mentioned uses.

Conclusion

Findings from this study suggest that data dashboards can be used to support internal decision making and monitoring of progress toward organization goals. For a data dashboard to be effective, data dashboard designers, in consultation with organizational stakeholders, must consider design guidelines for visualizations. They must also carefully consider which data to include. The study reveals a number of potential uses of data dashboards in a program evaluation context, which are internal use and external use. Internally, the data dashboard can serve as a monitoring tool that enables stakeholders to keep a finger on the pulse of different organizational activities and their alignment with goals. Moreover, data dashboards can be a tool that help in deciding on the evaluability of an organization in what is known as evaluability assessment. Indeed, evaluating the data, its availability, and its documentation would help in building the capacity of organizations for evaluation in what is known as evaluation capacity building.

Although data dashboards can be beneficial as internal tools for monitoring, they have the potential to be used externally as well. The study shows that data dashboards can be important tools to communicate performance and evaluation findings and for accountability too. However, with this external use, organizations need to judge the readiness of the surrounding social systems for this amount of transparency in order to avoid possible misuse of these data dashboards against organizations themselves. Although the study has concluded promising findings on the integration of data dashboards into evaluation practice, there is a need to study the use of these data dashboard in organizations for prolonged times to be able to confirm the sustainability of these data dashboards and their uses.

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Appendix

In this section, I present the data and codes in tabular format that explain the code, its definition, the corresponding text, and the overarching theme.

Table 10

1st Code: Perceptions of Design

Code final	Code definition	Comment scope	Comment text	Theme
1. PPERCEPTION OF DESIGN	The interviewees negative and positive perceptions of the design in general and of its specific components that range from font, colors, arrangement of items, and use of titles. It is also about their suggestions and questions.	<ul style="list-style-type: none"> • you had a title on knowledge mobilization and members survey so that help me sort of orient my gaze and find, but you don't have a title on funding • I like it • The colours and the distribution of the images I find it very well done • There is also enough room and it is not all crammed, and I like that • , you can see it without being saturated • I think it is agreeable too, you can see it without being saturated. • I like the colors too 	<p>DESIGN: -CONSISTENCY</p> <p>DESIGN: "I LIKE IT"</p> <p>DESIGN: +COLORS</p> <p>DESIGN: +IMAGES</p> <p>DESIGN: "NOT CRAMMED"</p> <p>DESIGN: VISUALLY FRIENDLY</p> <p>DESIGN: APPEALING</p> <p>DESIGN: +COLORS</p>	Effectiveness of Design

- I would like to see everything either from lowest to highest or from highest to lowest as opposed to it. DESIGN: -CONSISTENCY
 - the font is too small DESIGN: -SMALL FONT
 - Yeah it is very small DESIGN: -SMALL FONT
 - is it possible to sort of identify critical times when the budget might develop, there might be a feature on the dashboard that sort of raises an alarm for example or for a project become at a certain level? Is that a possible thing DESIGN: CURIOUS ABOUT FEATURES
 - is there a possibility the eye might be drawn to where you have used red and away from where you haven't used red. Would you need to be more consistent across all of the content areas to be sure that people didn't overlook something you are using? DESIGN: -CONSISTENCY
 - I mean if you are using your computer and you wanna see the DESIGN: CHANGE WINDOW SIZE?
-

dashboard and you change the size or the form

- But how is it be to create a dashboard for the different stakeholders using the same information but if we wanted to highlight certain components for different stakeholders?

DESIGN: CUROSITY OF
POSSIBE OTHER USES

- So it could be just the screen, you know but for me the, like, when you had the slides, when you go to your slide presentation, it showed me a dashboard and it kinda had I think it might have had five or six kinda boxes of information that were clearly distinguishable. This one is a bit more difficult that way , again it could be the screen but it is looking largely white so that sort of you know discerning that like I can certainly see a big dollar sign up on the corner and getting a sense that is about money and I've got these other boxes down on the bottom left

DESIGN: -VISUAL
DIFFICULTY

that are about the topics. And Twitter and Google Analytics is clear but it is kinda of for me it's sort of just visually for me to see what the chunks of information are that are being presented is more difficult in this particular presentation than the one you had in your slide, if you see what I mean.

- DESIGN: -CHUNKING
- DESIGN: -ORGANIZATION
- But again it could be, I can see there are very light kind of dividing lines but it is just on my screen right now it is kinda bright white and then the information is kinda presented on a bright white background. So, it's kind of a lot to take in without having it kinda broken out into then clear chunks
 - : But that is my first observation just when you first showed it to me, when my first reaction is, I
 - DESIGN: -BACKGROUND
 - COLOR
 - DESIGN: OVERWHELMING PRESENTATION

kinda felt a bit overwhelmed in terms of trying to discern what was being presented

- Yeah, I mean I don't, for me honestly, it would just be probably easier if I can just distinguish what the chunks of information are like if it is social media, Analytics it could be like a box Social Media Analytics, very clearly distinguished. But knowledge mobilization is that is very clear. Like that kind of title for me. Then the membership survey is even clearer

DESIGN: CHUNKING

- we get used to that as a team using the dashboard every team meeting, it would, we will get more used to that.

DESIGN: FAMILIARITY
WITH TIME

- what I'm having difficulty with, like in my mind I know CRECS very well and I have been involved in strategic planning, I know some of our issues and I'm having trouble kind of, I

DESIGN: CHOICE OF DATA
CHUNKS

don't know grasping why we are interested in some of these things versus some other things that we might wanna be talking about.

- Okay so I could see how that would be useful and there may be a dashboard that has core items that will always there like budget, the research productivity, the quantity or the quality of ongoing CRECS activities related to the value proposition of CRECS and may be like top priority projects or something so that would be a core kind of thing that would repeat every time and as we move through the plan we might wanna other things. I can certainly see the communications part you called knowledge mobilization, but basically the communications and knowledge mobilization part are key elements to that as well

DESIGN: "CORE ITEMS"

- as we have been doing our planning we have been talking about kind of the three you know what is the vision, mission, values of CRECS and what are our three pillars of activity and with whom. You know who is the community people we are working with underneath (unintelligible: 9:52). So, the three pillars, I won't remember them perfectly, but one of is certainly applied research including evaluation and another is training and knowledge mobilization and another one is about the third one I believe it is kinda like engagement with partners. And I guess what I would probably want when we get that more solidified would be a display here that kinda relates to those pillars so we could see how we are doing on each of those pillars.

DESIGN MODIFICATION:

ALIGNMENT WITH PILLARS

- this can be morphed a little bit to kinda take into account the three

DESIGN MODIFICATION:

ALIGNMENT WITH PILLARS

pillars of activity or our value proposition.

- it may not be only just the three pillars presentation, there may be some core elements that are kinda cross cutting here important to realizing all three of those. And I would think like money (laughs), communication would be two really important ones.

DESIGN MODIFICATION:
PILLARS AND CORE ITEMS

- The second one would be making sure we have the right chunks of information, we already talked about that related to how we really wanna proceed and what's really important with respect to our three pillars and where we are headed now with the strategic plan

DESIGN MODIFICATION:
ALIGNMENT WITH PILLARS

- the design is great
- It's got a lot of information on one page, which is pretty important
- the dollar sign

DESIGN: "GREAT"

DESIGN: COMPREHENSIVE

DESIGN: +SYMBOLS

- I love your knowledge
mobilization symbol DESIGN: +SYMBOLS “LOVE”
 - attractive. I think you’ve done
well DESIGN: “ATTRACTIVE”
 - I like the colors actually; I like
the colors a lot DESIGN: +COLOR
-

Table 11

2nd Code: Data Representativeness and Challenges

Code final	Code definition	Comment scope	Comment text	Theme
2. DATA REPRESENTATIVENESS & CHALLENGES	The code refers to CRECS data included in the dashboard, its quality, reliability, relevance, and usefulness. It also refers to participants' reactions to the data in the dashboard. These reactions include both negative and positive ones. It also refers to some of their perceived concerns regarding the data.	<ul style="list-style-type: none"> • some of these things are things that are going to fluctuate. • The membership survey is not a continuous activity that is may be a once a year or once every two year possibly depending on how often we're doing this kind of activity • would you then need manually to adjust the “only” in front of the “87”? • I mean I'm assuming they would change over time as our concerns, you know, change as we move through implementing the plan and the 	<p>DATA: UPDATING</p> <p>DATA: OUTDATED</p> <p>DATA: MANUAL ADJUSTMENT</p> <p>DATA: OUTDATED</p>	Data Representativeness & challenges

membership survey becomes less important and eventually would fall off and the data display might be replaced with something

- But I would want get this fairly correct in terms of what the important mean, priorities that we have in terms of data for making decisions and the second as I would be given how I've seen how our data collection have been done in the past for certain things and including kind of real time information on money issues

DATA: PRIORITIES

- you'd wanna have confidence that the data that is being set into a dashboard like this is reliable

DATA: CONCERNS
OF RELIABILITY

- So we wanna get that data collection done properly so that the data is reliable so having a dashboard and having us being concerned of what is in it is reliable than may be we push ourselves to have better data collection tools than what we currently have.

DATA: CONCERNS OF RELIABILITY
 - think there is something missing and it is partnerships.

DATA: MISSING “PARTNERS”
 - I’m not too sure what the membership survey gives us.

DATA: UNUSEFUL
 - wouldn’t typically represent such a small group as a percentage because 7 is just 57% is 4 of them I guess

DATA: CHOICE OF FORMAT
 - So that’s why I wonder whether that is the best use of space to have that there. And I think ideally what should be there is perhaps just the number

DATA: UNUSEFUL
-

of researchers and students and not this, the survey part

- Yeah I don't really think this (pointing at membership survey part) was fair up benefit to tell, see where we are at, I don't think this (pointing at the whole dashboard) is a summary of CRECS.

DATA:
INADEQUATE

- have partners in school boards, indigenous partners, government agencies, technology, whatever that called companies.

DATA: MISSING
"PARTNERS"

- students, they are mentioned there but not overwhelmingly mentioned

DATA: MISSING

- this does not convey our outreach with the community, our relationship with community and that's pretty important (laughs). And it doesn't also convey, well I guess it conveys Education and faculty of Social Sciences but it doesn't convey the other lens we have across the university or internationally. DATA: MISSING You know most, some of these projects are, if I think xx's Frontiers Project, it involves scholars from across uOttawa and elsewhere. RSEKN involved scholars from throughout Ontario.
-

- One of the things that I think CRECS prides itself on is engagement with community and this is not evident here at all so we really have to, we've got two strategic goals moving forward. The first one is about meeting mission of research building capacity and training, the second one is about sustainability and I'm not too sure whether the dashboard shows that at a glance or whether we'd have to search through it. So to evaluate CRECS, I think what the dashboard does is identifying some key performance indicators but there is some missing that we would have to make more prominent

DATA: MISSING
INTERNAL USE:
KPIS

- I'm just a bit interested in the boxes of the projects the seven fields of program evaluation. I think we might need to do some work there to refine how we're, what the fields are and I know our website is not up-to-date with the actual projects that are underway like one of the ones that is not there.
- DATA:
REFINEMENT
-

Table 12

3rd Code: Dashboard Uses

Code final	Code definition	Comment scope	Comment text	Theme
3. DASHBOARD USES IN CRECS	The code refers to the suggested uses of the dashboard internally and externally with different stakeholders for different purposes. It also refers to the concept of misuse of the dashboard.	<ul style="list-style-type: none"> it summarizes very well the activities of the CRECS. at some point we will align this with xx's strategic plan And one of the things that we might think about for a dashboard is including in it the things that we can, stuff we are able to report in the annual report it will have some key performance indicators that may be thinking about what annual report is and how this would speak to that, and as a director you know it enables us figure out how we are doing around 	<p>INTERNAL USE: SUMMARY</p> <p>INTERNAL USE: ALIGNMENT WITH STRATEGIC PLAN</p> <p>EXTERNAL USE: REPORTING</p> <p>INTERNAL USE: PROGRESS TO KEY GOALS</p> <p>EXTERNAL USE: REPORTING</p>	Use and Misuse

these kind of key things we are reporting to the vice president's office

- Yeah, so that brought a very good point about reporting outside

EXTERNAL USE:
REPORTING
 - you have some concepts in the dashboard that would be well understood by internal people that might not be so well understood outside like what is meant by reach, so I'm wondering in your concept of use are you including mistaken use or misuse.

MISTAKEN USE
 - I think this is a very useful tool for the management meetings

INTERNAL USES:
MEETINGS
 - But I don't see how it could be used by external people who don't know a lot about CRECS.

EXTERNAL USE:
UNUSEFUL OUTSIDE
 - Because for example, concerning the goals, I think that everybody in the management

EXTERNAL USE:
UNUSEFUL OUTSIDE
-

committee is aware of these goals but not necessarily other people

- Is it possible that it might be helpful for engaging students within CRECS and so to better understanding of what CRECS is all about

INTERNAL USE: ENGAGING STUDENTS

- You might see yourself here as a student.

INTERNAL USE: “YOU MIGHT SEE YOURSELF HERE AS A STUDENT”

- This might be eventually something that can help, you know, create some identity around CRECS

INTERNAL USES:
CREATING STUDENTS’
“IDENTITY AROUND
CRECS”

- So from a management perspective, we could sort of see a window that has student engagement indicators

INTERNAL USES: ADDING
STUDENT ENGAGEMENT
INDICATORS

- which then you can report back out to track on your training of high-quality professionals around CRECS

INTERNAL USE:
DOCUMENTING
STUDENTS’ TRAINING
EXTERNAL USE:
REPORTING

- So it could be helpful for the director to have , you know, in terms of decision making to really have a sort of a real time look at what is the operational budget to make sure that come January we need to sort of put money out of the door that we know earlier enough in sort of December/January rather than sort of finding out in March, you know, that helps us spend more intelligently I think.

INTERNAL USE: PLANNING
SPENDING

- Yeah , I think it resembles a lot of what your online banking will give you, right! So if we can break it down into a pie chart and say you are spending x number of dollars on knowledge mobilization and x number of dollars on colloquia then we could see where we are overspending or underspending. budget

INTERNAL USE: PLANNING
SPENDING

- versus if we were to use this at a meeting for example, and put it up on a screen and had it

INTERNAL USE: MEETINGS
 - visual breakdown of spending that might be easier than simply looking at an Excel spread sheet with the expenses

INTERNAL USE: VISUAL REPRESENTATION OF BUDGET
 - I think it is a basis of comparison

EVALUATION USE: “BASIS OF COMPARISON”
 - same data at various time points you would have a basis of comparison to see how things are progressing

INTERNAL USE: PROGRESS
 - it could be useful for some evaluation depending on those evaluation questions are

EVALUATION USE: POSSIBLE USE
 - but I primarily see this is having a monitoring role rather than an evaluation role.

INTERNAL USE: MONITORING TOOL
 - I would agree.

INTERNAL USE: MONITORING TOOL
-

- But It couldn't create your evaluation capacity as it is developing your systems for collecting these data. INTERNAL USE:
EVALUATION CAPACITY
BUILDING
 - Absolutely INTERNAL USE:
EVALUATION CAPACITY
BUILDING
 - Exactly INTERNAL USE:
EVALUATION CAPACITY
BUILDING
 - Because this would have this bringing all these data together in a way that's we simply don't have to INTERNAL USE:
EVALUATION CAPACITY
BUILDING
 - and showing us where we are not collecting INTERNAL USES: IDENTIFY
WEAKNESSES IN DATA
COLLECTION
 - Yes, I think so. It is clear because here you can see all the work that is done, the different parts of the university that are contributing to the functions in CRECS. I think, I think so yes EXTERNAL USE:
ACCOUNTABILITY
-

- that would be the other key to use, the prime use is that

EXTERNAL USE:
ACCOUNTABILITY

INTERNAL USE:
MONITORING TOOL
 - I think it gives us a point for discussion

INTERNAL USE: "POINT OF DISCUSSION"
 - critique perhaps

INTERNAL USE: CRITIQUE
 - It might perform a basis for how to communicate external with other folks

EXTERNAL USE: BASIS FOR OUTSIDE COMMUNICATION

INTERNAL USE: "MORE AS INTERNATL USE"
 - I see this more as internal use

INTERNAL USE
 - Yes, I agree with it

INTERNAL USE
 - sometimes having an object like this can divert some of that tension onto graphics. To things rather than people. There is some research on that.

INTERNAL USE: DIVERT TENSION

INTERNAL USE: POTENAIL ENHANCEMNT OF SHARED UNDERSTANDING
 - potentially

INTERNAL USE: POTENTIAL
 - I think it has potential yeah I would agree

INTERNAL USE:
POTENTIAL
-

- in the absence of any information at all this would certainly help to (laughs) to think about it

ENHANCEMENT OF SHARED UNDERSTANDING

INTERNAL USE: ENHANCES SHARED UNDERSTANDING
 - It would be interesting once we have our strategic plan each of the headings will relate back to the strategic goal and we could see a progress over time towards these goals that might be helpful

INTERNAL USE: ALIGNMENT TO STRATEGIC PLAN

INTERNAL USE: PROGRESS TOWARDS GOALS
 - I think it is good for the knowledge mobilization piece in evaluation

EXTERNAL USE: “KNOWLEDGE MOBILIZATION IN EVALUATION”
 - I think it is more of a monitoring tool

INTERNAL USE: MONITORING TOOL
 - I could see after the evaluation was complete and we wanted to highlight the findings to our stakeholder groups and if we created a different dashboard for the different

EXTERNAL USE: HIGHLIGHT EVALUATION FINDINGS
-

stakeholder groups, it could be very useful

- I can certainly see how this relates to objectives we have as a management team to, like currently our focus is on kinda renewing CRECS and renewing strategies that are driving some of our work over the next two or three year

INTERNAL USE:
RELEVANCE TO
OBJECTIVES

- it would probably be the first thing that we talk about each meeting, to kinda get a real sense of where things are at and how things are progressing, and are there any you know risks on the horizon, any crises, budgetary otherwise like those are such questions to me that are really important on a management team, so I can see this thing extremely useful that way

INTERNAL USE: SET
MEETING DIRECTION
INTERNAL USE: "CORE ON
THE AGENDA"

- Currently the way our agenda sort of comes together, we leave it up to the director to think about you know or the co-directors because they know what's going on more than the rest of the management team does across CRECS, we leave it up to them to create the agenda and they come to talk about what they want and sort of not a very proactive and probably not very helpful to them to be honest, way of having the meeting occur
- So I can see this being a nice menu for us to begin a meeting with and then we can branch out into like opportunities, risks, operational issues, strategic planning
- planning that kind of thing versus just kinda dealing with whatever crisis happens to be kinda of top of mind with the co-directors for the moment.

INTERNAL USE: ENHANCE
CURRENT INEFFECTIVE
MEETINGS

INTERNAL USE: "NICE
MENU"

INTERNAL USE: FUTURE
PROJECTION
INTERNAL USE: CRISIS
ANTICIPATION

- that's what I want, so running our meetings and being more productive and more helpful as a management team

INTERNAL USE: INCREASE PRODUCTIVITY
 - this would be very very useful especially from kinda correct information, chunks correct

INTERNAL USE: "VERY VERY USEFUL"
 - Obviously this would be really key in reporting to the stakeholders in the center, and I call them stakeholders but you can call them partners and funders or whatever else you want but we have to do that every year as a minimum and ah if we're tracking all of this information over the time and if we can simply include this dashboard or derivative of this dashboard as a way of structuring those reports then I think that would be extremely helpful to us as well

EXTERNAL USE: REPORTING TO STAKEHOLDERS

EXTERNAL USE: CREATE REPORTS
 - this would inform decision making for sure in a management team

INTERNAL USE: DECISION MAKING
-

assume you can rely on the
information and we didn't spend the
meeting arguing about the information

- Although you can say that if we
are doing that and arguing about it that
would be process use because then we
aren't clear on like data collection and
are our data reliable and valid and if
not can we do it better so you can see
how that would lead us down the track
possibly on process use

EVALUATION USE:

PROCESS USE

- a symbolic kind of use
relationship between a tool like this or
a derivative of this and a report and the
deans and the central administration
taking a quick look to see if they think
we're being productive enough to
consider us to be you know fundable
again for another year

EVALUATION USE:

SYMBOLIC USE

- , it is sort of projecting into the future and kind of thinking about what is your mission so that you are achieving objectives and creating some change in the university and in the world this too would be related to that because you have to be thinking about what is you know what is the logic of our center, what is the logic of change that we are trying to achieve or what is simply the operational logic that we're working under so I can see it feeding that

EVALUATION USE:
CONEPTUAL USE

- so and that for me so if you think about for example the symbolic relationship between reporting from this and to funders and I would say in particular to funders inside the university, whether there is a lot of politics around research centers and money all the time and everything, you can potentially see the transparency

MISUSE: TRANSPARENCY
BACKFIRES

provided by this, symbolically you could hope that the administrators would say we appreciate the transparency we trust you more, but politically what you could see happen is the transparency provided by this would used against us possibly

- someone then begin calculating other ratios from this information that they may think are not very, may not be assigned productivity but they have no benchmark for figuring that out and so then we become kind of the test case for (laughs) for that

MISUSE: "TEST CASE"

- And then they start imposing those ratios on other research centers and the next thing you know you have targets and the next thing you know you have all kinds of dysfunctional behavior and so on. So I could see there is a, there is a low risk of that but knowing the political life of

MISUSE: UNINTENDED

CONSEQUENCES

MISUSE: TRANSPARENCY

BACKFIRE

organizations it is still a concern for me about how much transparency you put into a system where there is a lack of transparency pre-existing

- I think the dashboard is a start for developing shared understanding, I think my last comments kinda got, I think it is a platform from which one could and should design a process of conversation and learning around the information in the dashboard

INTERNAL USE: “START”
FOR UNDERSTANDING

- So within the management team because we have quite a ,you know, a set of good rapport and yes we have arguments but we know each other well and so we can have open conversations, we are not scared of that as a management team, this would be very helpful to those I think

INTERNAL USE: USEFUL
INTERNALLY

- the reality of organizations is not like that. it is political, there is always you know kind of fights over resources, over profile, over reputation, all these things. So for me the separation between the management team and then out into the university community whether it is the Dean's or the central administration, is one avenue thought that needs to be getting very close consideration to how we're reporting and on what and are they prepared for the kinds of reports that we're gonna be giving them and if not how we can prepare them in a manner that we can actually make sure that (unintelligible 32:29) this isn't messing in a relationship and these won't be misused or used against us.

MISUSE: BACKFIRES

CONCERNS: READINESS OF

SOCIAL SYSTEMS

- I'd be excited to use this and have a conversation with the management team on a regular basis about this kind of information rather than the kinds of management team meetings that we've had historically which are relatively formal and usually dealing with kinda one of issues that are sort of swirling around the environment, doesn't feel organized and I don't feel like I'm providing a high value being in those meetings, this might provide some focus to our conversation.

INTERNAL USES: FOCUSES CONVERSATION
INTERNAL USES: SET MEETING DIRECTION
 - we need partners to be present and this tells me that partners are not present on our website at all

INTERNAL USE: IDENTIFY POOR PERFORMANCE (WEBSITE)
 - this tells me a lot just in an overview

INTERNAL USE: "OVERVIEW"
 - The Ten-Minute Windows are far more popular than I thought they were. Although the Ten-Minute

INTERNAL USE: IDENTIFY GOOD PERFORMANCE (TMW)
-

Windows last year were based mainly around equity and that so we did promote them hugely so that is indigenous and equity

- Twitter engagement shows the age of the people
INTERNAL USE: IDENTIFY POOR PERFORMANCE: (TWITTER)
 - So we are really not doing well in terms of outreach and virtual presence at all
INTERNAL USE: IDENTIFY POOR PERFORMANCE (VIRTUAL)
 - as director, it definitely shows us, me where we are at
INTERNAL USE: INDICATION OF PERFROMANCE
 - it shows me more than anything is what we have to work on.
INTERNAL USE: IDENTIFY AND ENHANCE
 - I would use this for a special meeting with the management team to set goals, strategic goals for 2019
INTENRAL USE: SETTING STRATEGIC GOALS
INTERNAL USE: MEETINGS
 - But really I think we would use this to sit as a management team because it shows me what's wrong with CRECS, you know, it shows me,
INTERNAL USE: MEETINGS
-

it draws attention and the other thing that is not there

- But we will definitely use this as a management team to see how it aligns with the strategic plan that we've

INTERNAL USE:
ALIGNMENT WITH
STRATEGIC PLAN

- this is what CRECS looks like to somebody who comes and examines what is available to her. What's, what do we have to do?

INTERNAL USE: DECISION
MAKING
USES: OUTSIDER VIEW

- definitely! I think it will guide

INTERNAL USE: GUIDANCE

- it will definitely help us as a lens or a framework to examine our web presence

INTERNAL USE: "LENS"

- it is a very useful tool for setting directions and goals I think.

INTERNAL USE: "TOOL FOR
SETTING DIRECTIONS"

- evaluate CRECS alignment with our strategic goals

INTERNAL USE:
ALIGNMENT WITH GOALS

- what the dashboard does is identifying some key performance indicators but there is some missing

INTERNAL USE: KEY
PERFORMANCE
INDICATORS

that we would have to make more prominent

- I hadn't thought of that

EXTERNAL USE:
ACCOUNTABILITY
"HADN'T THOUGHT OF THAT"
 - it could also be shared with members every year, you know as a this is what we have achieved

EXTERNAL USE:
COMMUNICATION TOOL
 - as a tool to keep us on track and to focus our goals

INTERNAL USE:
MONITORING
 - it could be with, it would need some supplementation

EXTERNAL USE:
ACCOUNTABILITY WITH
"SUPPLEMENTATION"
 - a synthesis tool for accountability so that they can look and see, yeah it's CRECS is on track.

EXTERNAL USE:
ACCOUNTABILITY
"SYNTHESIS TOOL"
 - to keep us honest in CRECS

INTERNAL USE:
TRANSPARENCY
 - focus on with the appointment is cleaning up our website, because that's what you have shown. I know

UNINTEDED USE
-

that wasn't your intent, but what it's revealed is how bad our website is basically.

- it certainly allows collective engagement of a management committee because

INTERNAL USE:
PROMOTING
ENGAGEMENT
FUTURE DIRECTION:
"WE'LL CONTINUE TO USE IT"
 - a tool that we'll continue to use

EXTERNAL USE:
COMMUNICATION TOOL
INTERNAL USE: PLANNING
TOOL
EXTERNAL USE:
"SYNTHESIS TOOL"
 - we could send this out as a newsletter to all our partners as evidence of what we are doing. So we could use it both as a planning tool and as synthesis to report to members as well as funding bodies, the two faculties and the OVPR. But yeah as a communication tool

INTERNAL USE:
MONITORING TOOL
INTERNAL USE: DECISION
MAKING TOOL
-

- yeah, I think it is a very one-glance indication of what CRECS is doing and how we are moving

INTERNAL USE: “ONE-GLANCE INDICATION”
 - see something like this perhaps with less detail almost being a landing page of a website and then people can go into it.

INTERNAL USE: WEBSITE LANDING PAGE
 - that I’m super pleased we changed from RSEKN to CRECS because this is so useful to us

USE: “SO USEFUL”
USE: “SUPER PLEASSED”
 - this will help us determine what our tasks are

INTERNAL USE:
DETERMINE TASKS
 - it is super useful to us

INTERNAL USE: “SUPER USEFUL”
 - done work that will make a difference to CRECS and CRECS forward planning

INTERNAL USE: EFFECT ON PLANNING
-

Table 13

4th Code: Future Directions

Code final	Code definition	Comment scope	Comment text	Theme
4. FUTURE DIRECTIONS	This code refers to the how CRECS will act in the future upon the findings of this dashboard	<ul style="list-style-type: none"> it is a goal displacement comes to mind right away, right I don't think so. Because I think this kind of decisions about your network depend on individual conditions. So I don't think the dashboard is gonna be we push ourselves to have better data collection tools than what we currently have. that would change some of the things that and we wouldn't be doing at the last minute and have people don't respond or whatever and we haven't defined what we're really looking for clearly enough for them to 	<p>FUTURE DECISION: GOAL DISPLACEMENT</p> <p>FUTURE DECISION: NO EFFECT</p> <p>FUTURE DIRECTION: BETTER DATA COLLECTION</p> <p>FUTURE DIRECTION: BETTER DATA COLELCTION</p>	Future Directions

respond properly and all those sort of questions.

- The partnerships are invisible on our website. Clearly there is something wrong, that doesn't jump up and it wasn't even enough for you to even record it. So it is clearly unavailable there, it is not obvious to people. So I think that tells us that we have to change our website

FUTURE DIRECTION:
DECISION MAKING:
"CHANGE"
 - Now XX has a grant to enhance Twitter and social media so hopefully we'll see a difference if we did the same thing next year.

FUTURE DIRECTION:
DECISION TAKEN FOR
ENHANCEMENT
 - We already done little things in relation to it with XX taking the social media, we've got a grant for that. We are applying for another grant from the same group

FUTURE DIRECTION:
ENHANCING SOCIAL
MEDIA
 - a tool that we'll continue to use

FUTURE DIRECTION:
"WE'LL CONTINUE TO
USE IT"
-

- So somebody has to teach me how to do it. I'll talk to XX. Yeah it is my responsibility and the management responsibility to really build this tweeting stuff.

FUTURE DIRECTION:
MORE TWEETING AS A
DIRECTOR

- keep working with the new person on what has to happen with the website

FUTURE DIRECTION:
CHANGING THE WEBSITE
FUTURE DIRECTION:
DECIDING CRITERIA FOR
NEW COORDINATOR

Table 14

5th Code: Concerns and Limitations

Code final	Code definition	Comment scope	Comment text	Theme
5. CONCERNS AND LIMITATIONS	The code refers to the concerns that the participants expressed regarding the integration of the dashboard in their system and the limitations of this dashboard as a platform for data analysis and visualization	<ul style="list-style-type: none"> • Just because there is a possibility that people might misinterpret if they are in, you know, if you use it like a boundary object, you are moving it outside sort of the norm group. • You may need to find some way to offer contextualization around, you know, why they may be differences between...yeah...to interpret those data for people that don't know. • it is possible that one person at the table might interpret reach differently from another person at the table and you can walk away from meeting thinking you each understand what each other is talking about but this will hinge on that discussion 	<p>CONERN: DATA MISINTERPRETATION</p> <p>CONCERN: DATA MISINTERPRETATION</p> <p>CONCERN: MISINTERPRETATION</p>	Concerns and Limitations

- But I do think, you brought up a good point Barbara, about the cognitive interviewing piece and I feel that cognitive interviewing would be needed here to make sure that we are all interpreting these key pieces the same way
- the other issue too just is not being able to do real time updates but having to input data
- And it opens up an opportunity for air not being caught, like the longer the pipeline of your data
- that piece of the dashboard that is currently taken up by the membership survey to somehow position something that is more qualitative to not forget something that you know, I don't know. Dedicate a piece of it for, even if you left it blank

CONCERN:
MISINTEPRETATION

LIMITATION: DATA INPUT

LIMITATION: MISS DATA

LIMITATION: OUTDATED
DATA

- The caveat for that to me is just making sure that that what we put on that menu is actually what's really important for us both in the short term and the longer term and that we are not kinda let astray or blinded by the information we have on that dashboard and not attending to other potentially important information that may be in the environment

CONCERNS: SIGHT
LIMITATION

- . I mean I do think there is a high value of this but there is also unintended consequences that flow from the use of data supposedly to improve you know conceptual learning or process related learning or instrumental decision making but the symbolic and political nature of accountability often brings unintended consequences to the people who are trying to do the right thing and so this is always a concern for me, and you need

CONCERNS: VALUE VS
CONSEQUENCES
CONCERNS: POLITICAL
CONTEXT

to think about that symbolic and political context I think quiet deeply before you just innocently launch your great transparency upon the world.

- I think this would be very helpful in the team if we and ideally we would at some point every year possibly like on an annual basis or I don't know if you want to do it more frequently but we could have an event or a process by which this gets kinda of a summary version, this gets presented to the stakeholders and we somehow do that in a manner that causes us to actually have an interaction with them around it that would be focused more on learning and less on being counting and accountability and the construction of new ratios of this data that can be used

CONCERNS: VALUE VS
CONSEQUENCES

to impose certain role views on us then
I think it would be helpful.

- accountability and learning in an evaluation context is always heavy on the accountability and that gets in the way of actually having real conversations about how to improve, how to innovate, how to you know how to work together better going forward and also what should be paid attention to in the future

CONCERNS:

ACCOUNTABILITY

OVERPOWER

- I don't think you are going to that kind of environment naively thinking that you are presenting data and being transparent and therefore we are gonna learn together and focus on that and we have also demonstrated

CONCERNS: "NAÏVE
VIEW"

accountability by giving this to you,
that's I think that is a very naïve view.

- the dashboard itself I don't think would do that. I think it could have opposite effects.

CONCERNS: ADVERSE
EFFECT

- it can't be inserted into a social system in itself and expect that is going to have the intended effect of causing people to engage, people to learn, people to be reciprocal in their understanding of what's going on and so forth. I think there needs to be a serious thought to how that social system operates and how one inserts it in there as a resource to have a conversation focused on not just accountability but on learning, improving, and innovating

CONCERNS: READINESS
OF SOCIAL SYSTEMS

- So that would be my view.

Again it is not to enter to these things kinda naively the tool as great as it is, it is only a tool but the social relationships around the tool are what need to be considered and how the use of the tool may alter those in ways that are unintended if one doesn't sort of approach it with a clear intent and some design about how to have a conversation.

CONCERNS: NAÏVE
INSERTION

- capability to develop good data for in CRECS and the amount of effort that would be required to do that in a manner that will be confident that we are reviewing credible high quality valid reliable data

CONCERNS:
AVAILABILITY OF
RELIABLE DATA

- there is the issue of what is the effort required to get it would be question I have in my mind and you would know better because you had to go get it. and you know where it came

CONCERNS: EFFORT TO
GET DATA

from and probably assess the credibility of the sources from which it came.

- be it needs constant review overtime to kinda replace certain elements

LIMITATION: CONSTANT REVIEWING

- inserting the dashboard into a social system in which we haven't had one of these before and making sure we do that in a manner that it gives some thought to how that is going to affect the conversations we are having with them and paying attention to how those conversations are unfolding as we use it to make sure that it is serving a purpose to help us learn and manage better and should the report be accountable

CONCERNS: READINESS OF SOCIAL SYSTEM
CONCERNS: NAÏVE INSERTION

- it's a little bit like an overview. I feel like you have to drill down into the boxes to find that exactly, the details I guess.

LIMITATION: NEEDED DETAILS
